PL-CNS-05-001

INTERIM SITE STABILIZATION AND CLOSURE PLAN FOR THE BARNWELL LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY 2005 CLOSURE PLAN

June 2005

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1.0 INTRODUCTION

Chem-Nuclear Systems (CNS) operates a low-level radioactive waste disposal facility located approximately five miles west of the city of Barnwell, in Barnwell County, South Carolina. The site comprises approximately 235 acres of property owned by the State of South Carolina. CNS leases the site from the Budget and Control Board of the State of South Carolina, which will become the custodial agency after burial operations and site closure have been completed.

CNS operates the disposal facility under South Carolina Department of Health and Environmental Control (DHEC) Radioactive Material License No. 097 (License 097). The license specifies requirements for receipt, handling and disposal of radioactive waste and delineates the requirements for operation of the site as a low-level radioactive waste disposal facility.

1.1 Purpose

The purpose of the Interim Site Stabilization and Closure Plan (the Closure Plan) is (1) to summarize the activities completed to date to close and decommission the site, (2) to describe the remaining activities required to close and decommission the site, (3) to provide a cost estimate for remaining closure activities and compare it to the amount in the decommissioning trust fund, (4) to describe activities to be performed during the post-closure observation period, (5) to describe activities to be performed during the long-term care period, (6) to provide a cost estimate for long-term care (institutional control) and compare it to the amount in the long-term care fund, and (7) to perform a re-assessment of operating practices to ensure that on-going operational activities are consistent with proposed closure activities and goals.

The Closure Plan provides a documented path of actions leading to stabilization and final closure of the Barnwell Low-Level Radioactive Waste Disposal Facility (Barnwell site). After stabilization and final closure, the site must continue to meet performance objectives specified by License 097. The plan discusses the disposition of the buildings and structures on the leased property, planned disposal area stabilization

activities and closure performance objectives. Planned post-closure and long-term care maintenance and monitoring of the site and the availability of funds for all these activities are also discussed.

1.2 Scope

This document is a revision and update of the 2000 Closure Plan, designed to be consistent with S.C. Code Ann. §48-46-40 (B)(6) (Supp. 2003), which established (1) time frames for operations and (2) limits on disposal volumes. CNS has designed an approach for closure consistent with these time frames as shown on Figure 1-1.

CNS assumes four fundamental time periods during the remaining life of the disposal facility. They are as follows:

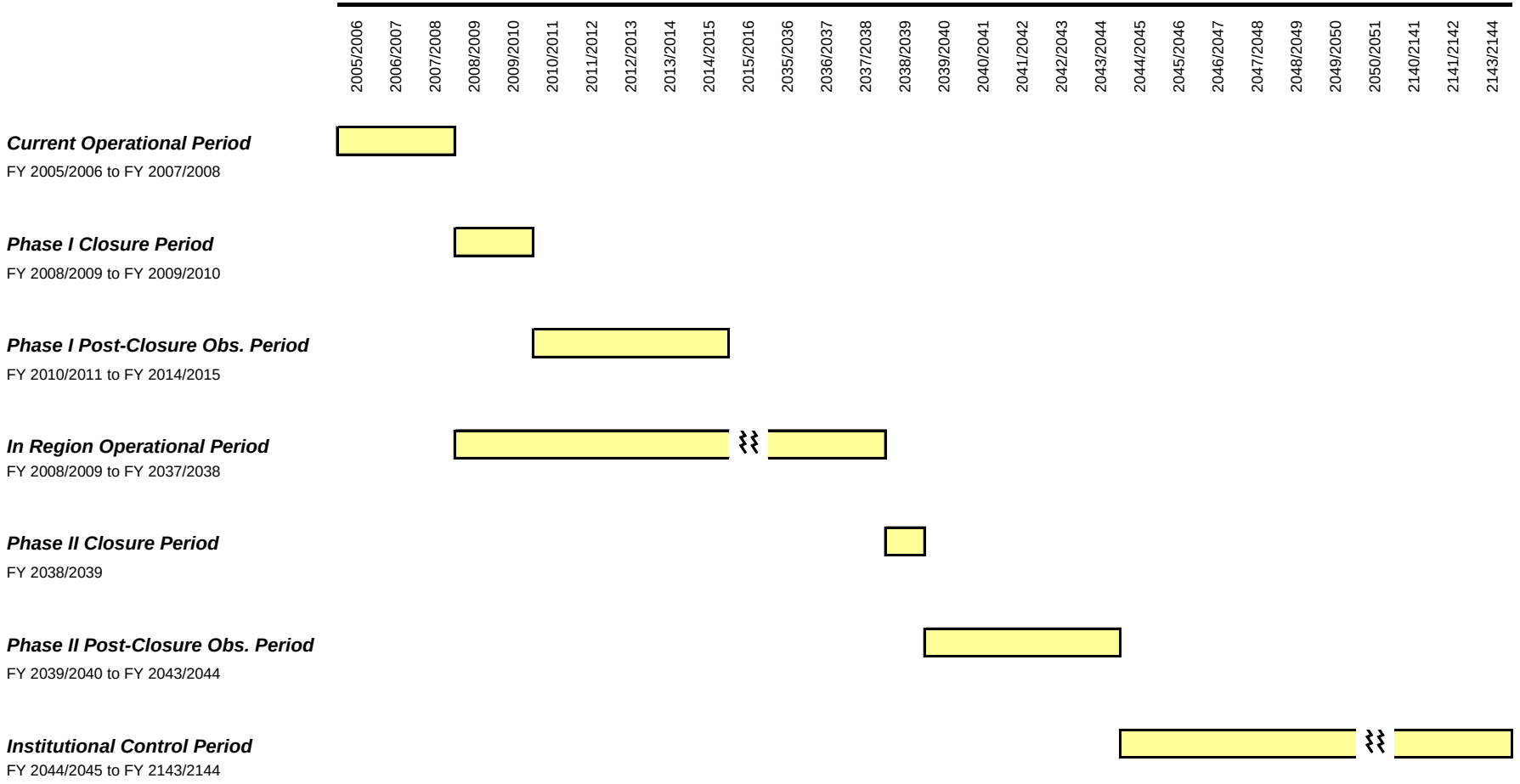
(1) Three remaining years of operation receiving low-level radioactive waste (LLRW) disposal volumes up to that allowed by §48-46-40 (B)(6) of the S.C. Code (as amended). This period extends from FY 2005/2006 through FY 2007/2008.

(2) Thirty years of operation as an “in-region-only” disposal facility. CNS assumes this period will end in 2038, although the in-region-only period could extend more or less than thirty years depending on site capacity and other considerations. The initial two years of this period (Phase I closure) will be used to complete closure activities on all parts of the disposal site except those areas required for in-region disposal operations. Phase I closure will be followed by a five-year post-closure observation period (Phase I post-closure) for closed parts of the site.

(3) Following in-region operations, one year will be devoted to in-region operations final closure (Phase II closure), and five years to in-region period final post-closure observation (Phase II post-closure).

(4) One hundred years of institutional control will follow the Phase II closure and post-closure periods. CNS assumes institutional control will end in 2144.

Figure 1-1
Barnwell Site Projected Timeline



For purposes of evaluating the adequacy of the decommissioning trust fund only, it is assumed that site closure activities occur after the next three years of operations. This assumption provides a conservative evaluation of the adequacy of the decommissioning trust fund.

2.0 HISTORICAL BACKGROUND

This section reviews the history of regulatory actions, legislative actions, the licensed disposal area, trench construction and maintenance, waste characterization and packaging and radionuclide inventory. It also traces the evolution of the site, reviewing how these aspects have been affected by regulatory and political changes.

2.1 Regulatory Documents

Four major documents have governed the Barnwell site, its operation and disposition since CNS was licensed to store waste in 1969. These documents are the Lease Agreement and its amendments, South Carolina Radioactive Material License 097, U.S. NRC Radioactive Material License No. 12-13536-01 and the Decommissioning Trust Agreement of 1981.

Lease Agreement and Amendments: CNS entered into a 99-year lease agreement with the South Carolina Budget and Control Board on April 21, 1971, to lease 17.2 acres of land, previously deeded to the State by CNS, for the purpose of burial of radioactive waste. Under this agreement, CNS agreed to operate in accordance with its license application, the conditions of its License 097 and the requirements of the U.S. Atomic Energy Commission. The agreement also established a fund for the long-term care of the site. CNS agreed to pay eight cents into the fund for every cubic foot of waste received for burial.

The Lease Agreement was amended on April 6, 1976, replacing the previous agreement and expanding the lease area to its present 235 acres. At the same time, the long-term care fund payment was increased to sixteen cents per cubic foot. The agreement included a formula for increasing the fund based on the Consumer Price Index. Since 1985, the payment to the long-term care fund has been set at $2.80 per cubic foot. Other conditions of the lease have remained substantially the same since inception.

South Carolina Radioactive Material License 097: The most important document affecting operations and closure of the site, License 097, was issued by DHEC in 1969 authorizing receipt and storage of low-level waste. Following extensive geohydrological investigations, the license was amended in 1971 to authorize disposal of low-level waste by shallow land burial. State and federal agency involvement and DHEC approval preceded authorization for burial.

License 097 specifies requirements by which CNS operates the disposal site. The license describes trench construction specifications, backfilling and capping requirements and required trench markings. Requirements for acceptable wastes are covered as well as specific documentation that must accompany each shipment from the generator. Waste shipments and vehicles must comply with United States Department of Transportation (DOT) regulations for transport and receipt at the site and even more stringent license conditions for acceptance, burial and vehicle release.

The DHEC license has been amended forty-eight times since it was issued in 1969. Amendments cover a range of changes, from modifying a single license condition to a complete rewrite consolidating several previous amendments into a single document. Due to straightforward and open interactions between CNS and DHEC, the amendments have resulted in positive changes and improvements to the burial site and its long-term integrity. An application to renew the license was submitted to DHEC April 27, 2000, and site activities continue with the license in timely renewal status.

NRC Radioactive Material License No. 12-13536-01: In 1975, this license for receipt and disposal of special nuclear material (SNM) was issued to CNS at the Barnwell site. The main purpose of the license was to allow CNS to receive larger quantities of SNM than permitted by the State license. Agreement states cannot authorize receipt of SNM in amounts greater than allowed by the U.S. Atomic Energy Act of 1954, as amended.

The larger possession limits of SNM, mainly uranium-235, allowed waste generators to ship full loads rather than partial loads of the same waste materials to the site and provided for some storage capabilities for SNM wastes if required by inclement weather or lack of trench space. The license specified a total unburied possession limit of 4500 grams for U-235 and 200 grams for U-233. In addition, the license imposed a maximum per-package quantity of 350 grams of U-235 and 200 grams of U-233. On January 1, 1990, the DHEC license was amended to eliminate the disposal conditions related to SNM wastes because they were already covered under the NRC license.

Because the number of SNM waste shipments to the site had dropped dramatically during the mid-1990's, CNS elected to terminate the NRC license and submitted a request to DHEC for SNM disposal approval under License 097. The decrease in SNM shipments was primarily due to the decommissioning of facilities that once produced such wastes and SNM shipments being directed to another disposal facility. On June 9, 1997, DHEC amended License 097 to include SNM waste disposal. With the inclusion of SNM in License 097, the NRC license was terminated. Current unburied possession limits for U-235 and U-233 wastes are 350 grams and 200 grams, respectively.

Decommissioning Trust Agreement of 1981: On March 24, 1981, CNS entered into a Trust Agreement with the State of South Carolina to provide monies for establishment of a decommissioning fund. This fund must contain sufficient monies to decommission and stabilize the site in accordance with the requirements of the Closure Plan. In 1981, at the time CNS entered into the Trust Agreement, CNS contributed a lump sum of approximately $1.7 million to the decommissioning fund. No additional contributions were made until April 1, 1993, when $4.11 per cubic foot of waste disposed at the Barnwell site was contributed to the fund. This contribution lasted for three months. Contributions were again reinstated effective January 1, 1994, at $12.60 per cubic foot to cover costs of enhanced capping at the Barnwell site. On July 1, 1995, the contribution was reduced to the current $4.20 per cubic foot. CNS evaluates the adequacy of the fund balance annually.

2.2 Regulatory/Political History

During the early 1970's, the Barnwell site was one of six commercially operated disposal sites. By 1979, three of the commercial sites (in Illinois, Kentucky and New York) had closed, and the Barnwell site was receiving more than three-fourths of the nation's waste.

The increased rate of waste receipt led to South Carolina establishing limits on the annual volume of waste allowed to be received at the site. The volume restriction program gradually reduced allowable volume by one-half over a two-year period (1979-1981) to 1.2 million cubic feet per year. This restriction remained in effect until June 2000 with the enactment of the Atlantic Interstate Low-Level Radioactive Waste Compact Implementation Act (Atlantic Compact Act), which established the current limits on volume.

During 1979, South Carolina developed and promulgated Regulation Number 61-83, "Transportation of Radioactive Materials Into and Through the State of South Carolina." This regulation established a permit system for waste generators shipping LLRW in the State, and a prior notification system to provide DHEC and CNS advance notification of shipments passing through the State and arriving at the site. The system requires that shippers certify that shipments have been inspected and meet the requirements of appropriate regulations and license conditions.

In 1980, the U.S. Congress passed the Low-Level Radioactive Waste Policy Act. The Act established three major policies. First, that each state is responsible for the low-level waste generated within its boundaries. Second, states may form compacts (or groups of states) to facilitate managing low-level waste generated within the boundaries of the compact states, including the right to deny disposal of out-of-compact wastes at compact disposal facilities. The Act also established the policy that these compacts could not refuse waste from other states until the U.S. Congress had ratified the compact. The Southeast Compact, consisting of eight southeastern states (Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee and Virginia) was formed, with the Barnwell site designated the regional facility.

In December 1982, NRC promulgated 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Wastes," which became effective in December 1983. This regulation specifies technical requirements applicable to the different phases of a disposal facility: licensing, operations, closure, post-closure surveillance and institutional control. As a matter of Agreement State compatibility, DHEC adopted 10 CFR Part 61 – equivalent regulations.

On January 1, 1986, the Low-Level Radioactive Waste Policy Amendments Act was signed into law, making a generator's continued access to the three operating disposal sites contingent on its compact meeting specified milestones for new site development. The amended Act clarified Congress' intent to require compacts (or individual states not within a compact) to provide disposal capacity for LLRW generated within their boundaries by January 1, 1993. The legislation also defined the LLRW for which states are responsible. It mandated Federal responsibility for all waste for which states are not responsible above NRC 10 CFR Part 61 Class C limits. The amended Act also established conditions for access to operating disposal sites during the interim period, allowed the partial rebate of surcharges to states and compacts which meet statutory milestones and established penalties for states that fail to meet the mandated site development goals. A US Supreme Court decision in 1992 struck down the penalty portion of the amended Act.

The South Carolina General Assembly (SCGA), in its 1992 session, enacted legislation to allow the Barnwell site to continue as the regional facility until December 31, 1995, subject to several conditions. One condition required states outside the Southeast Compact to demonstrate progress in developing their own regional disposal sites in order to retain access to the Barnwell facility during an 18-month period (January 1993 through June 1994). After June 30, 1994, the Barnwell facility would accept waste from Southeast Compact generators only. By 1995, continued delays in building a new regional disposal site led South Carolina's governor to propose legislation to withdraw the state from the Southeast Compact.

In June of 1995, the SCGA enacted the legislation, South Carolina withdrew from the Southeast Compact, and the Barnwell facility began accepting waste from generators in all states except North Carolina and the Northwest Compact. North Carolina was restricted from site use due to its failure to develop the next disposal facility. The Northwest Compact states disposed of their LLRW at a facility in Washington. South Carolina also imposed a $235 per cubic foot tax on all waste received for disposal at the Barnwell facility. Proceeds from this tax went to the Children's Education Endowment Fund and have been used for educational scholarships and school construction.

Effective July 1, 2000, the Atlantic Compact Act enabled South Carolina to join the Atlantic Compact (formerly the Northeast Compact). Provisions in the legislation limit waste volumes on a yearly basis, repeal the tax and after eight years restrict acceptance of waste to three states: South Carolina, Connecticut, and New Jersey.

2.3 Licensed Disposal Area

The initial licensed area consisted of approximately 17.2 acres leased from the South Carolina Budget and Control Board for disposal operations. This tract of land was part of a larger property evaluated and found suitable for use as a disposal site during the site's licensing phase (1969 to 1971).

The Lease Agreement was amended in 1976, enlarging the licensed disposal area to the current 235 acres. CNS Drawing #B-500-D-300 shows the 235 acre disposal area boundary, trench locations, ancillary facilities and fence lines.

2.4 Trench Construction and Maintenance

The original document permitting burial at the Barnwell site was issued April 1971 as Amendment 3 to License 097. This section summarizes the history of changes in trench design and construction and significant maintenance actions.

2.4.1 Trench Construction

1971 to 1983: As specified in Amendment 3, the first trenches were shallow earthen excavations. The waste was placed into these excavations, surrounded and covered with backfill material, and then capped with clay. The clay cap was covered with a sheet of 10-mil plastic, over which additional protective soil was placed. Trench excavations were required to be located above the water table.

Amendment 5 (April 1973) established several new trench design requirements, including standard trench dimensions. This amendment also required that a gravel-filled drain (French drain) be placed in the bottom center of each new trench, running the length of the trench. Monitoring pipes located at specific intervals were placed in the French drain. Also incorporated into the trench design was trench floor sand surrounding and covering the French drain. The trench cover was reduced in thickness and no longer included 10-mil plastic.

Amendment 12 (December 1975) established design criteria for the slit trench. The new slit trench was similar to other trenches with the exception of width, which was greatly reduced. This trench was designed to provide a disposal method for higher activity waste such as irradiated reactor hardware. Amendment 12 also required placing the French drain and monitoring standpipes along the sidewall of the trenches to reduce the possibility of pipe damage during waste placement.

Amendment 15 (July, 1977) allowed larger trenches to be constructed. The larger trench size allowed CNS to arrange waste more efficiently to make better use of trench space and to reduce personnel exposure by using low-activity waste as shielding. This amendment also changed cover design, requiring a minimum thickness of clay and general earth cover.

1983 to 1996: At the end of 1982, NRC regulation 10 CFR 61 was promulgated. Amendment 36 facilitated the implementation of 10 CFR 61 at the Barnwell site by requiring segregation of wastes according to waste class. Amendment 36 describes the use of three separate trench designs to segregate wastes. The new trench designations were Class A, slit trench (C-type) and Class B/C waste trench.

In 1988, CNS improved the design of the trench floor French drain system based on an evaluation of the existing system and trench drainage properties. CNS changed trench standpipes and screens from polyvinyl chloride (PVC) to stainless steel, and the French drain gravel materials to a coarse sand. The benefits were (1) the steel standpipe provides greater resistance to collapse and bending during trench disposal and backfilling operations, and (2) coarse sand minimizes the infiltration of fines into the French drain.

Amendment 45 (January 1990) required that CNS place polyethylene high integrity containers (HICs) containing Class B or C wastes in concrete vaults. This change was made to resolve concerns regarding the long-term stability of the polyethylene HICs.

In 1991, CNS changed cap design to reduce the likelihood and size of subsidence features on CNS trench caps.

During 1993, CNS began placing slit trench wastes in concrete vaults, eliminating the need for a concrete intrusion barrier on subsequent slit trenches.

1995 to Present: Amendment 46 (August 1995) required several substantial changes to trench design and construction. These changes included placing all waste in concrete vaults (unless otherwise approved by DHEC), modifying the French drain system in the Class A trench and covering all future trenches with enhanced multi-layer earthen cap.

In 2004, CNS changed trench backfill material type and installation methods to minimize settlement and subsidence on trench covers. CNS recommended and DHEC approved use of only free-flowing materials for backfill in most trenches. CNS also committed to using specific equipment to fill the voids between disposal vaults.

2.4.2 Trench Maintenance Actions

In addition to on-going routine disposal site and trench maintenance (see Section 3.2.3), CNS has implemented several significant maintenance activities and cover enhancements affecting disposal trenches at the Barnwell site. These activities are summarized below.

The first significant trench maintenance activity at the Barnwell Site occurred during 1978 and 1979. It involved grading to improve drainage over several trenches on the southern part of the disposal site (southern trench area). In 1987, the caps of several trenches in the same area were upgraded to remove native sand found adjacent to these trenches. Topsoil and surface sand around the perimeter of these trenches were excavated to native clay. Clay soils were then added and compacted to form a continuous clay cap and a buffer around the perimeter of these trenches. Topsoil was then replaced and the area seeded and fertilized. These activities were performed to decrease infiltration of surface water, limit erosion and achieve final closure elevations in this area. Further upgrades to this area were completed in 1992, as described below.

The next significant action, completed during 1992, was installation of the first cap enhancement on the Barnwell site. This construction action occurred in the southern trench area, a 12.5 acre area on the south end of the disposal site (see CNS drawing B-500-D-300). The cap enhancement construction involved regrading existing trench covers to improve drainage, recompacting clay soils and adding synthetic barrier materials (polyethylene and bentonite mat), sand drainage materials and general earth cover

(see Section 6.2.1 for further details). The enhanced covers significantly reduce rainwater infiltration through trench covers and establish final closure grades.

Between 1993 and 2005, CNS completed five additional enhanced cap projects, bringing total trench area covered to approximately 96 acres, or approximately 80% of the site.

2.5 Waste Characteristics and Packaging

Over the years, the Barnwell site has disposed of numerous types and quantities of radioactive wastes. This section briefly highlights the predominant waste forms and their effect on site disposal.

2.5.1 Solidified Waste

Since the beginning of site operations, CNS has buried solidified liquid at the Barnwell site. Liquid wastes cannot be shipped to or buried at the site. It is the waste generator's responsibility to ensure that all such wastes are properly solidified prior to shipment. Solidification methods have varied from the early use of absorbent material, such as vermiculite, to the present method of using approved solidification media such as cement.

2.5.2 Scintillation Materials

Scintillation materials, mostly in the form of liquid scintillation vials, were acceptable for burial at the site until May 1979. These wastes were packaged with absorbent materials and in some cases doubly-contained in steel drums. In 1979, receipt of this material was prohibited because of the chemicals involved (toluene, xylene, benzene) and their potential to migrate from the trench. Several non-hazardous scintillation products have been approved by DHEC for disposal at the Barnwell site provided they are properly solidified and packaged.

2.5.3 Calcium Fluoride

From 1979 through 1981, the site received approximately 851,000 cubic feet of calcium fluoride containing low concentrations of uranium. Most of this waste was disposed in Trench No. 34. No other waste types were placed in this trench. Trench No. 30, designated for the receipt of institutional waste, received some of the calcium fluoride. However, a clay barrier running the width of the trench separated the calcium fluoride from other waste forms.

2.5.4 Dry Active Waste

Dry active waste (DAW) is material that has become contaminated with radioactivity, including paper, plastic, rubble, scrap metal, asbestos and soil. DAW is received for disposal in strong-tight steel or wooden containers. This waste form makes up the majority of the Class A waste volume. Most of the DAW currently being received has been compacted to reduce volume.

2.5.5 High Integrity Containers

Stabilization of certain waste forms through the use of high integrity containers (HIC) began in 1981. DHEC was the first regulatory agency to review and approve such containers. The material composition of the HICs ranges from high-density polyethylene to special non-corrosive metals.

In December 1989, NRC notified CNS that then-current polyethylene HIC designs did not meet long-term structural stability requirements. CNS developed a concrete disposal vault designed to meet structural requirements and received DHEC approval for its use in conjunction with the disposal of polyethylene HICs. In addition, the disposal vaults were approved as engineered intruder barriers. This allowed the disposal of Class C waste without the required five meters of overburden.

Polyethylene HICs containing Class B or Class C wastes have been placed in these disposal vaults since 1990. All Class B and Class C wastes regardless of their waste forms or container types have been disposed in concrete vaults since July 1993. Effective January 1, 1996, DHEC required all wastes regardless of waste class to be placed in disposal vaults. However, DHEC has allowed some exceptions, such as large component wastes (i.e. steam generators), provided they meet the site's stability requirements.

2.5.6 Incinerator Ash

A portion of the DAW received for disposal is incinerator ash. Incinerator ash wastes must be rendered non-dispersible prior to shipment. Rendering it non-dispersible reduces the possibility that radioactive materials will be dispersed should a transportation or site-operation handling mishap occur. Methods for rendering ash non-dispersible include solidification, placement in a HIC and mixing with a binding matrix or double packaging. The volume of this waste form has increased significantly over the past few years, because higher disposal costs have made incineration cost-effective.

2.5.7 Filter Materials

Ion-exchange resins and filter media from nuclear plant generators have also accounted for a significant percentage of site disposal. Before receipt, these materials must be dewatered and placed in approved HICs or solidified.

2.5.8 Irradiated Hardware

Irradiated hardware is comprised mostly of metal components that have been subjected to neutron bombardment inside a nuclear reactor. The components may include control rod blades, shroud head bolts, non-fuel reactor components, etc. Irradiated hardware comprises a small percentage of the total volume disposed at the site. Most of these shipments are Class C waste and are buried in

slit trenches. Concrete vaults have been used in the slit trench for the disposal of this type of waste since July 1993.

2.5.9 Sealed Sources

Sealed sources account for a small percentage of the overall volume disposed at the site. Although these sources are typically received in their original source holders, only the size of the source is considered for waste classification purposes. Therefore, a small source with a minimum quantity of activity may exceed Class C limits. In 1989, CNS received DHEC concurrence to evaluate the acceptance for disposal of sealed sources containing Table II radionuclides, provided each source was less than 10 curies and encapsulated in a minimum of 4 inches of cement (Tables I and II radionuclides are provided in License 097). The cement must have a minimum compressive strength of 2500 pounds per square inch.

In 1993, DHEC expanded the approval process to allow CNS to evaluate the acceptance of non-transuranic sealed sources from Table I radionuclides, provided the source is less than the following specified limits:

^{14}C 100µCi	^{59}Ni 100µCi
^{63}Ni 0.1µCi	^{99}Tc 10µCi
^{129}I 0.1µCi	

Sources with radionuclides other than Radium, and transuranics with specific activities that do not exceed Class A limits, assuming a source volume of one cubic centimeter, may be disposed as Class A waste packaged as dry active waste.

2.5.10 Large Component Wastes

Large component wastes are usually large, heavy items shipped from commercial nuclear plants. Such items include steam generators, reactor pressure vessels, etc., that are shipped to the disposal site by combinations of barge, railway, and special over-

the-highway transport equipment. Disposal of such components is a significant project that usually takes years of planning and often requires review and approval from both state and federal agencies. Through December 31, 2004, large components disposed by utilities include 17 steam generators, five reactor pressure vessels, and one pressurizer. One barge used by the US Navy to process radioactive waste has also been disposed.

2.6 Site Inventory Summary

CNS tracks twenty radionuclides accounting for over 90 percent of the site's current radioactivity inventory. This list of radionuclides and radioactivity was originally provided by DHEC in August 1982. Since that time, CNS has updated monthly the quantities of these radionuclides received and amount decayed. Table 2-1 is a current (decay-corrected) inventory of these selected twenty radionuclides buried at Barnwell as of December 31, 2004.

In December 1982, NRC implemented 10 CFR 61, which required waste generators to provide a more detailed characterization of the radioactivity in their wastes. The regulation required that specific radionuclides used in the classification system and their activities be recorded on the disposal manifest.

The site's radionuclide inventory for waste received subsequent to implementation of 10 CFR Part 61 is provided in Table 2-2. This table provides a list of radionuclides and the quantity (in curies) of each received (not decay-corrected) during the period January 1, 1983, through December 31, 2004. It consists of the 10 CFR Part 61 classification table radionuclides and other short- (< 5-yr. half-life) and long-lived radionuclides not considered important in waste classification.

The annual volume of waste buried at the Barnwell site has varied significantly over the years, from approximately 50,000 ft^3 in 1971 to approximately 2,445,000 ft^3 in 1980. The total volume of waste buried at the site through December 31, 2004 was 28,066,910.21 ft^3. Table 2-3 lists the total volume buried each year.

Table 2-1
Selected Twenty Radionuclides by Quantity

Radionuclide[1]	Activity (Curies)[2]
Cobalt-60	1,444,801.40
Iron-55	589,481.38
Cesium-137	270,415.00
Hydrogen-3	334,454.64
Nickel-63	355,858.01
Manganese-54	7,343.64
Strontium-90	11,006.05
Cesium-134	3,482.53
Zinc-65	730.08
Chromium-51	44.04
Uranium-238	5,245.29
Krypton-85	548.15
Cobalt-58	321.45
Cerium-144	59.43
Zirconium-95	3.61
Iron-59	13.09
Strontium-89	1.01
Iodine-125	0
Cerium-141	0
Ruthenium-103	0.15
Total	3,023,808.95

(1) Selected isotopes.
(2) Current radioactivity as of December 31, 2004

Table 2-2
Radionuclides Received at Barnwell
(January 1, 1983 – December 31, 2004)

10 CFR Part 61 Nuclides	
Radionuclides	*Activity (Curies)*
Cobalt-60	3,930,477.80
Hydrogen-3	547,283.97
Nickel-63	371,466.91
Cesium-137	119,494.13
Strontium-90	11,971.29
Carbon-14	2,988.62
Nickel-59	2,963.69
Plutonium-241	535.20
Technetium-99	99.38
Curium-242	60.59
Transuranics (Alpha emitters with half-lives greater than 5 years)	63.49
Niobium-94	16.18
Iodine-129	9.53
Other Nuclides	
Nuclides with less than 5 year half-life	4,407,913.18
Actinium – 227	0.006
Aluminum – 26	0.001
Barium – 133	8.24
Bismuth – 207	24.12
Cadmium – 113m	85.52
Cesium – 135	2.94
Chlorine –36	1.44
Chlorine – 38	0.12
Depleted Uranium	2,499.71
Europium – 152	4.64
Europium – 154	4.72
Krypton – 85	409.44
Lead – 210	0.63
Molybdenum –93	126.70
Niobium – 93m	0.36
Potassium –40	4.73
Promethium – 145	0.0009
Protactinium – 231	0.018
Radium – 226	22.29
Radium – 228	48.64
Rhenium – 187	0.01
Samarium – 151	2.07
Silver – 108m	20.53
Technetium – 97	0.002
Technetium – 98	0.0003
Thorium – 230	5.05
Thorium – 232	2,129.74
Uranium – 232	0.30
Uranium – 233	1.12
Uranium – 234	33.80
Uranium – 235	13.26
Uranium – 236	0.26
Uranium – 238	2,001.34
Zirconium – 93	0.61
Total	**9,402,796.31**

Table 2-3 Barnwell Burial Volumes	
Year	Volume (cubic feet)
1971	50,219.34
1972	159,933.47
1973	599,886.28
1974	624,759.55
1975	643,564.44
1976	1,393,587.55
1977	1,636,425.12
1978	2,220,519.72
1979	2,238,322.13
1980	2,444,810.72*
1981	1,543,278.67*
1982	1,228,200.83*
1983	1,240,668.21*
1984	1,231,715.28*
1985	1,214,422.99*
1986	1,053,791.68*
1987	958,275.82*
1988	931,974.01
1989	1,103,299.56
1990	788,031.90
1991	789,681.85
1992	828,727.84
1993	605,443.07
1994	733,896.31
1995	484,890.82
1996	325,815.32
1997	222,269.48
1998	195,684.08
1999	166,435.79
2000	117,965.54
2001	109,591.83
2002	52,163.23
2003	71,416.22
2004	57,241.56
Total	28,066,910.21

* Burial volumes include container pallet volumes for years 1980 through 1987

2.6.1 Waste Form/Packaging Requirements History

Since waste disposal at the site began in the early 1970's, many changes have occurred affecting the acceptability of wastes, waste packaging and methods for disposal. This section describes the history of waste types received and disposal methods.

Typical waste types disposed in the first years of operations were utility wastes consisting of dewatered resins, absorbed liquids and DAW. Institutional and industrial wastes were received in the form of biological materials, absorbed liquids, liquid scintillation vials surrounded with absorbent material (vermiculite), general laboratory trash, DAW, source and SNM materials. These wastes were generally packaged in metal drums, wooden or metal boxes (mostly wooden) and steel liners. A considerable amount of biological waste containing mostly H-3 and C-14 was packaged in paper containers.

In April 1974, DHEC prohibited the receipt of utility-generated liquids processed in absorbent materials. These liquids had to be processed by cement solidification.

In July 1977, the license was amended to broaden the list of acceptable solidification media. These included cement (already being used), urea formaldehyde, DOW® ion exchange media, Delaware Custom media (solidification) and asphalt. Absorbed institutional liquids and scintillation vials continued to be accepted as previously discussed; however, most of these wastes were disposed in separate trenches.

In May 1979, hazardous scintillation liquids were prohibited from site disposal. Also, institutional liquids had to be solidified.

In July 1981, a significant change in the radioactive material license occurred. The change required all ion-exchange resin and filter media bearing isotopes having half lives greater than 5 years, and having a combined activity of one microcurie per cubic centimeter,

to be solidified or placed in a DHEC-approved HIC. Solidification products were DOW® media, cement, urea formaldehyde, asphalt and Delaware Custom media. Urea formaldehyde was discontinued as an acceptable solidification medium in September 1981. Biological wastes were required to be double-packaged in metal containers with absorbent material and lime added to the waste and the interstitial space between containers filled with absorbent materials.

The operational requirements of 10 CFR Part 61 were implemented at the site during 1982. This required certain waste, based on specific radionuclides and concentrations, to be processed/packaged in a more stable form. Since most of these wastes were already packaged in HICs, the biggest effect was the requirement to segregate waste into separate trenches based on waste class.

In 1989, NRC concluded that the current design of polyethylene HICs did not meet long-term stability requirements. A concrete vault was approved by DHEC to allow continued acceptance and disposal of Class B and C waste within the polyethylene HICs.

Since 1996, CNS has buried all waste in DHEC-approved vaults. These vaults are designed to provide structural integrity to all waste packages. Large waste components may be disposed without vaults with DHEC concurrence.

In 2003, DHEC approved CNS's request to dispose of all classes of wastes in the same trench. This approval allows for the disposal of packages containing Class A Stable, Class B and Class C wastes in the same waste vault. Class A Unstable wastes may be disposed of in the same trench; however, they cannot be disposed of in vaults containing stable wastes.

2.6.2 Radionuclide Reporting History

Wastes received for disposal are documented on shipment/disposal manifests. The manifest has evolved during the site's history to meet regulatory requirements and site reporting needs. During the early years of disposal, the manifest did not require specific radionuclide information. Often, only the single most abundant radionuclide or a small percentage of the nuclides were listed. During the late 1970's and early 1980's, radionuclide reporting improved as a result of regulatory reporting changes. Isotopes such as C-14, H-3, etc., (usually shipped by private industries and universities) were specifically listed on the manifests, enabling their existence and quantities to be traced back to their origin. However, in the case of power plant generated wastes, nuclide reporting was still limited mainly to the more abundant nuclides such as easily identified gamma emitters.

With the full implementation of 10 CFR Part 61 in 1983, radionuclide reporting vastly improved to meet waste stabilization and classification requirements. Specific waste stream samples from power plants were analyzed for hard-to-identify radionuclides by independent labs. Scaling factors were also developed to better estimate radionuclides in waste streams.

2.6.3 Estimation of Long-Lived Inventory

CNS evaluated the need to estimate the quantity of radionuclides that may not have been included in earlier waste manifests. Conclusions of that evaluation are summarized below:

- CNS can produce only an estimate of radionuclide inventory because reconstruction requires professional judgment and assumptions.
- CNS estimated the quantity of long-lived radionuclides that may be disposed at the Barnwell site. CNS found that these estimations of radionuclide inventory compare favorably with independent sources of radionuclide inventory data.

3.0 OPERATIONAL SUMMARY

The following section describes current practices associated with disposal site operations, including activities related to meeting performance objectives, waste forms and classification, regulatory oversight, disposal trenches, ancillary facilities, surface water management and environmental monitoring programs.

3.1 Regulatory Requirements

The disposal of low-level radioactive waste at the Barnwell site is governed by the requirements of License 097. The license provides the requirements for operating, closing, and maintaining a disposal facility in compliance with DHEC regulation 61-63, “Radioactive Materials” (Title A). Title A incorporates the requirements of NRC regulation 10 CFR Part 61 (Licensing Requirements for Land Disposal of Radioactive Wastes) and 10 CFR Part 20 (Standards for Protection against Radiation). Radioactive material disposal requirements are discussed below. (CNS also complies with all other applicable federal [OSHA, EPA, etc.] and state regulations).

3.1.1 Performance Objectives

In December 1982, NRC promulgated 10 CFR Part 61, "Licensing Requirements For Land Disposal of Radioactive Wastes,” which became effective in December 1983. These requirements have been incorporated into License 097 as well as into DHEC Regulation 61-63 (Title A). Part 61 specifies the basic requirements for land disposal of low-level radioactive waste, including disposal facility licensing, operation, closure, post-closure, and institutional control phases. This regulation emphasizes waste and disposal site stability and the goal of limiting access to waste. It established a waste classification system, consisting of three waste classes with associated radionuclide concentration limits. Some of the key requirements of Part 61 as embodied in the specific performance objectives in Subpart C of the regulation are described below.

The performance objectives have been established to protect the public from releases of radioactivity, to protect individuals during operations, to ensure stability of the disposal site after closure, and to protect individuals from inadvertent intrusion into the waste after active institutional controls are terminated. The time frame for maintaining controls over waste buried in a Part 61 site is 500 years.

The performance objectives require that every reasonable effort be made to maintain radiation exposures as low as reasonably achievable. Operations must be conducted in compliance with the standards for radiation protection in 10 CFR Part 20, the requirements of which are incorporated in DHEC Regulation 61-63, Title A.

Radioactive material releases to the environment in groundwater, surface water, air, soil, plants or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, or 25 millirems to any other organ of the body for any member of the public.

The disposal facility must be sited, designed, used, operated, and closed in such a manner as to achieve long-term stability and to eliminate, to the extent practicable, the need for ongoing active maintenance following closure so that only surveillance, monitoring, or minor custodial care are required.

Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.

Each performance objective and the methods being used or planned to be used to confirm compliance are discussed in Section 9.0 of this document.

3.1.2 Waste Form and Classification

Waste form and classification are the primary factors affecting waste acceptance and disposal at the Barnwell site. Waste class is determined by evaluating the types and concentrations of long- and short-lived radionuclides in a waste and applying the specific requirements in SC Regulation 61-63 (Title A). Waste form also affects method and location of disposal. Stable waste forms provide, in and of themselves, isolation and confinement of the radioactive material. Unstable waste forms are those for which radioactive material confinement is provided primarily by the geohydrologic features of the burial environment. Waste classification, form, and disposal criteria are described further below.

Class A wastes contain the lowest concentrations of radioactivity and are not required to be structurally stable for burial. Class B wastes contain higher concentrations of radioactivity and must meet rigorous requirements on waste form to ensure stability after closure.

Class A and B wastes can be buried without intrusion protection because they contain types and quantities of radioisotopes that will decay during the 100-year institutional control period and therefore do not pose an appreciable hazard to an intruder.

Class C wastes contain long-lived radionuclides and high concentrations of radioactivity. These wastes must meet the physical form requirements of Class A, the stability requirements of Class B, and must be protected against inadvertent intrusion.

Class C wastes must be disposed so waste is at least five meters below land surface, or disposal must incorporate intruder barriers that are designed to protect against inadvertent intrusion for a least 500 years.

3.1.3 Regulatory Oversight

CNS operates its disposal facility in accordance with License 097 issued by DHEC. To ensure compliance with the facility license, DHEC routinely inspects facility operations. A DHEC official stationed at Barnwell inspects each incoming shipment and burial operations on a daily basis. DHEC engineers visit the site weekly to inspect trenches and site conditions. Also, periodic unannounced inspections are made by DHEC officials typically to audit facility records for compliance with license and other applicable regulatory requirements.

DHEC also inspects and approves each trench before CNS begins burial operations. Final trench approval is based on several DHEC inspections performed during trench construction. DHEC also reviews and approves trench designs, trench construction and other facility procedures, and special waste types for burial.

In the area of radioactive material transportation, the U.S. DOT and DHEC have the authority to inspect waste shipments upon arrival at the Barnwell site to ensure compliance with federal shipping regulations.

To ensure compliance with regulatory requirements and continued success during regulatory and other external audits, CNS maintains an internal audit program. The results of internal audits are made available for regulatory review.

3.2 Disposal Trenches

Current Barnwell site trench design and construction practices are governed by DHEC-approved trench construction procedures and trench construction detail drawings. According to License 097, changes to these documents must be approved by DHEC prior to implementation. Trench areas are qualified for use prior to trench construction in accordance with a CNS-approved procedure.

3.2.1 Disposal Trench Qualification

Trench areas are qualified for use prior to trench construction. A geotechnical and hydrological trench qualification investigation is performed in the proposed trench area to demonstrate satisfactory soil characteristics and water table conditions, as well as suitable proposed trench design.

Site conditions (surface drainage, access) and information from existing boreholes are evaluated as the initial phase of field investigation. Additional exploratory boreholes are drilled if available information is insufficient to characterize the geology of the proposed trench area.

Nearby water table wells are used to determine maximum historic water levels in the area. These data are used to establish the maximum trench depth.

CNS combines trench data and evaluations along with the proposed trench design drawings into a trench qualification report, which is submitted to DHEC for review and approval. Construction begins after DHEC approval. CNS and DHEC verify conformance to design by inspections at designated hold-points in accordance with the trench construction procedure.

3.2.2 Current Trench Designs

Disposal trenches are constructed in accordance with approved construction procedure, appropriate trench construction detail drawing and a specific proposed trench design drawing. The drawings are approved by DHEC prior to use. The construction process is controlled through a series of documented hold points and inspections.

Prior to excavation, a Registered Land Surveyor (RLS) lays out the trench boundaries in accordance with the approved proposed trench drawing. The larger Class A and Class B/C trenches are

constructed using a combination of hydraulic excavators, dump trucks, motor graders and tractor scrapers. During construction, temporary trench ramps provide access to the excavation area. Due to their narrow and steep-walled design, slit trenches are excavated entirely from the top. CNS allows no personnel entry into slit trench excavation during construction or trench operations. CNS excavates slit trenches using a hydraulic excavator and dump trucks, often in sections of limited length. CNS then extends the slit trench, as needed, based on waste receipt projections, thereby minimizing trench exposure to rainfall, runoff, and other forms of weathering.

As excavation proceeds in all trench types, the RLS monitors elevations and sloping and establishes trench bottom elevations. Disposal trenches include systems for collection and removal of water entering the closed trench.

CNS conducts formal and informal inspections throughout the construction process, and DHEC performs several formal inspections as outlined in construction procedures. Formal DHEC inspections occur after (1) trench excavation, (2) drain system construction, and (3) final floor sand installation. After final trench approval, CNS prepares an as-built trench drawing and documentation package. Pertinent documents are maintained as permanent trench construction records.

3.2.3 Site Maintenance

As required by License 097, CNS implements a comprehensive site inspection and maintenance program to ensure trench cap integrity and to maintain proper surface water drainage. All completed trenches are inspected monthly and after substantial rainfall. General disposal site inspections occur weekly. The inspections identify concerns such as erosion, settlement, and water ponding on or around trench areas and ensure timely repair.

CNS maintains records of inspections and maintenance actions. These records document disposal area performance and provide data for estimating future trench maintenance requirements.

CNS manages surface water in accordance with the requirements of License 097 and State NPDES regulations. The primary requirements of License 097 are to eliminate run-in of surface water into open trenches, efficiently drain rainwater off of closed trench caps to minimize potential infiltration, and contour trench covers to minimize erosion. These considerations are addressed in the trench construction procedure and by final cover design, both of which are approved by DHEC before implementation. NPDES requirements are implemented through a Storm Water Pollution Prevention Plan (SWPPP). The purpose of the SWPPP is to establish measures to minimize the release of pollutants (including sediment) from the disposal site in storm water.

3.3 Site Ancillary Facilities

CNS maintains several facilities on and adjacent to the Barnwell site, some directly supporting site operations and others related to parent company business lines. Table 3-1 lists existing facilities supporting the disposal operation, their current use and location. Buildings are described further below.

The Nuclear Services Clean Shop (No. 1) provides space and facilities for testing and repair of non-contaminated CNS waste processing equipment. It is also used for machining, welding and performing electrical repairs in general support of the Barnwell complex.

Receiving Warehouse No. 2 (No. 2) is the point of receipt and inspection for shipments of non-waste materials and supplies to the disposal site and other facilities in the Barnwell Complex. Goods are inventoried and stored here until needed and certain routine supplies are kept and dispositioned from this location. CNS also stores selected environmental samples at a secured location in this building. These samples are retained for five years after sample collection.

Warehouse No. 3 (No. 3) is primarily used for storage of materials and supplies associated with parent company activities, such as ion-exchange media and waste processing equipment. However, CNS also uses the facility as a geological core storage area, in support of disposal site characterization.

The Administration Building (No. 4) houses most of the site administrative staff including Site Management, Security, Personnel, Finance, and Regulatory Affairs. The main access gate is adjacent to the building and controlled by Security whose office overlooks the gate. The Administration Building is on CNS property, but the roadway and access gate are on leased state property.

The Transportation Maintenance Shop (No. 5) is operated by Hittman Transport, Inc. The shop is used for the maintenance of their transportation fleet including tractors, trailers and casks, and includes office space for the Hittman administrative staff. The shop includes three repair/inspection bays, one welding bay, one painting bay, and a parts storage area. Hittman provides transportation services to customers of the Barnwell site.

The Environmental and Dosimetry Laboratory (BEDL) (No. 6) contains facilities and equipment for radiological analysis of air, water, and soil samples collected as part of the Barnwell site environmental monitoring program. The laboratory also provides company-wide radiological personnel monitoring services, such as whole body counting, bioassay, and dosimetry services. The laboratory's professional technical staff performs disposal site engineering design, environmental characterization, and site performance studies. Radioactive Material License 287-03 authorizes possession and use of radioactive material in the analytical laboratory.

In the Liner Operations Building (No. 7), CNS receives, prepares, inspects, and stores liners and high integrity container (HICs). Liners and HICs are provided to CNS customers for use in processing and shipping waste. Although manufactured elsewhere, CNS customizes the liners and HICs for customers by manufacturing and installing internal structures (for

de-watering projects), attaching lifting devices, and adding foam to HIC tops and bottoms, as required.

Table 3-1
CNS Barnwell Ancillary Facilities

Number[1]	Name	Location[2]	Use[3]
1	Nuclear Services Clean Shop	CN	DTK
2	Receiving Warehouse No. 2	SP/RA	CNS/DTK
3	Warehouse No. 3	SP/RA	CNS/DTK
4	Administration Building	CN	CNS/DTK
5	Transportation Maintenance Shop	CN	DTK
6	Environmental & Dosimetry Laboratory	CN	CNS
7	Liner Operations Building	SP	DTK
8	Site Building	SP/RA	CNS
10	Health Physics Building	SP/RA	CNS
11	Site Operations Maintenance Building	RA	CNS
13	Cask Preservation Building	RA	CNS/DTK
14	Cask Maintenance Building	RA	CNS/DTK
15	Field Services Maintenance Warehouse	RA	DTK
16	Grounds Maintenance Shop	RA	CNS
19	Drilling Equipment Storage Trailer	RA	CNS
20	Instrument Calibration Shop	CN	CNS/DTK
21	Nuclear Services Support Facility	CN	DTK
22	Scaffolding Storage Building	CN	DTK

(1) Building numbers correspond to CNS Drawing B-500-D-300.
(2) The location codes indicate facility is on State Property (SP), CNS Property (CN), disposal site restricted area (RA) or bordering restricted area fence (SP/RA).
(3) The use codes indicate if facility supports CNS disposal activities (CNS), Duratek (DTK) or is shared between CNS and Duratek (CNS/DTK).

The Site Building (No. 8) is the personnel access and egress point for the disposal site restricted area. Security staff control vehicle and personnel access to the controlled area at this location. Monitoring equipment is provided for routine self-monitoring to detect personnel contamination upon exiting the site. The Site Building also includes site employee lockers, a break room, a health physics technicians room to support the performance of radiological surveys of waste transport units and office space, and an office for the DHEC on-site inspector.

The Health Physics Building (No. 10) provides office space for health physics technicians to perform radiological surveys of waste transport vehicles exiting the site and other routine radiological protection tasks. The building also houses contamination smear counting equipment and meters used for rad surveys.

The Site Operations Maintenance Building (No. 11) provides facilities for preventive maintenance and repair of equipment used in the daily operations of the site, including a carpenter's shop.

The Cask Preservation Building (No. 13) contains temporary covered parking facilities for trailers and casks and for sand blasting equipment. A separate bay is provided for blasting surfaces with abrasives to reduce contamination (such as cask interiors) or to prepare surfaces for painting (such as cask exteriors). This bay is sealed and maintained under negative pressure during operations, with exhausts passing through High Efficiency Particulate Air (HEPA) filters before release.

The Cask Maintenance Building (CMB) (No. 14) is used to prepare casks for offloading (removing rain covers, loosening lid bolts, etc.), decreasing radiation exposure and improving efficiency and safety during offloading. Casks are also prepared here for release from the site.

The Field Services Maintenance Warehouse (No. 15) has been used for the storage and decontamination of contaminated field equipment primarily used in utility fuel pools. It contains a small, 12-foot deep simulated fuel pool for testing equipment and training personnel. This facility is currently in use as storage.

The Grounds Maintenance Shop (No. 16), which is attached to the Cask Maintenance Building, provides storage space for disposal site grounds maintenance equipment and supplies.

The Drilling Equipment Storage Trailer (No. 19) contains parts and supplies in support of drilling operations and environmental sampling at the disposal site.

The Instrument Calibration Shop (No. 20) provides space for calibration of health physics equipment. It also houses instrument calibration sources. Radioactive Material License 287-01 authorizes possession and use of radioactive material in the calibration source area.

The Nuclear Services Support Facility (NSSF) (No. 21) provides space and facilities for testing, repairs and decontamination of CNS waste processing equipment. Radioactive Material License 287-02 authorizes possession and use of radioactive material in the NSSF.

The Scaffolding Storage Building (No. 22) provides storage space for scaffolding after receipt and inspection.

3.4 Environmental Monitoring

CNS manages both radiological and non-radiological monitoring programs for the Barnwell site. These programs are designed to assure that any releases of waste materials can be readily detected during operation of the site or following closure. The monitoring programs are designed to protect workers, the public, and the environment from harmful levels of radioactivity and other regulated chemicals. Monitoring programs include constant surveillance and research on all possible pathways for transport of radioactive and potential non-radioactive materials through environmental media. Non-radiological program requirements are based on 40 CFR 122, Appendix D, Tables II and III. The radiological monitoring program objectives incorporate International Commission on Radiological Protection (ICRP) guidelines. These objectives (from ICRP publication No. 43) (ICRP, 1984) are listed below.

The primary objectives of the radiological monitoring program are:

- To assess actual or potential doses to critical groups and populations from the presence of radioactive materials or radiation fields in the environment from normal operations or accidents. This may be limited to the assessment of dose equivalents to critical groups or may extend to the assessment of collective dose equivalents to populations.

- To demonstrate compliance with authorized limits and legal requirements.
- To check the condition of the source, the adequacy of operation of the site, or containment, and the effectiveness of effluent control, to provide a warning of unusual or unforeseen conditions and, where appropriate, trigger a special radiological monitoring program.

The secondary objectives of the monitoring program are:

- To disseminate monitoring information to the regulatory agencies.
- To maintain a continuing record of the effect of the installation or practice on pre-existing environmental radioactivity levels.
- To distinguish contributions from the operator's installation or practice from contributions from other sources.
- To obtain data on the behavior of materials in the local environment that may be required in assessment of the consequences of accidents.
- To identify changes in the relative importance of transfer pathways and mechanisms including the emergence of new pathways, and hence, to enable the radiological monitoring program to be revised in light of experience and in response to changing conditions.
- To verify or refine the predictions of environmental models, in order to improve the structure of the model and to reduce uncertainties in the parameters.
- To conduct more general scientific studies aimed at improving knowledge about radionuclides in the environment.

CNS' program includes a careful record of background radioactivity and contributions from other sources, thorough analysis of results, continuous characterization of the site and surrounding area to ensure realistic assessments, and on-going research to improve knowledge of radioactive materials in the environment.

3.4.1 Radiological Monitoring Program

CNS monitors the atmosphere, soil, vegetation, surface water, sediment, and groundwater. In addition, instruments are carefully

located to check direct radiation from the site. Each of these areas is discussed briefly in the sections that follow.

Atmospheric Monitoring

CNS implements atmospheric monitoring around the perimeter of the disposal facility as well as around active disposal areas. Atmospheric monitoring is concentrated close to active disposal areas in order to increase the likelihood of detecting any potential release soon after it occurs. A particulate filter and gaseous sample is taken in the disposal trench or at the side of the trench near the edge of the wall where the waste is being buried. This air monitor is positioned downwind and moved whenever there is a shift in wind direction. Additional air sampling is performed on an as-needed basis.

Continuous air samples are taken at permanently located stations on the site boundary. Most nuclear facilities locate these stations based on meteorological data, with preference given to those sectors where the wind is directed at the highest frequency. However, consistent with ICRP guidance, Barnwell site air stations are located uniformly around the site. Uniform spacing enables CNS to distinguish between radioactive materials potentially released by other adjacent facilities and the Barnwell site. The best method of assuring that all sectors are adequately monitored and that all precautions are taken to measure releases from other facilities is by locating air sampling stations uniformly around the site.

Boundary air stations are enclosed in an approximately 20-foot by 20-foot fenced area. The purpose of the protective fence is to guarantee an undisturbed plot of ground and vegetation free of fertilizers or other chemicals that may be used around the site to enhance the growth of grass and trees. Since fertilizers are frequently high in natural radioactivity, they could affect the ability to identify small changes in radioactivity.

Soil and Vegetation

Surface soil samples are taken to detect deposition and early infiltration of radioactive material into the soil. Characteristically, tritium and other soluble species have the potential to move through the top layer of the soil rapidly. Surface soil samples provide detection of early or on-going deposition of such radionuclides. Insoluble species, which move much more slowly and are not readily distributed in soil, would tend to remain near-surface. In this case, samples help demonstrate if airborne radioactive material has been deposited as a result of routine site operation. Likewise, samples of vegetation may also indicate whether radioactive materials are being deposited. However, these samples may indicate that radionuclides are being taken up through the roots of plants.

Surface Water and Sediments

Surface water and sediments are collected at the Barnwell facility. Particular attention is given to surface waters outside the site boundary that could be used as drinking water by the public or animals. Downgradient of the disposal site, CNS monitors where groundwater first emerges to join surface streams. At the Barnwell site, shallow groundwater discharges at the headwaters of Mary's Branch. Water and sediments are monitored at this location, as well as at three other stream locations in the vicinity.

Groundwater

The most important facet of any environmental monitoring program for a low-level radioactive waste site is groundwater. CNS strongly believes that a fundamental understanding of the geology and hydrology of the area is central to a successful environmental monitoring program.

Currently, an extensive network of both on- and off-site wells is monitored routinely for radioactive materials. On-site wells monitor groundwater near trench locations and at the site boundary. Off-site wells are located both up- and down-gradient from the site to as much as three miles away. Wells are strategically positioned in all directions to permit analysis of groundwater upgradient as well as downgradient of the site to determine baseline radiologic conditions.

Thermoluminescent Dosimeters

Each environmental station is equipped with a set of thermoluminescent dosimeters (TLDs) to measure external exposure from penetrating gamma radiation. These dosimeters are also located at intervals of approximately 300 feet along the perimeter of the site.

Current Program Summary

The sample collection schedules for the on- and off-site areas including number of each sample type, the frequency of sampling, and analyses performed are shown in Table 3-2.

CNS estimates that there are at least 30 private water wells within one half mile of the disposal site boundary. Currently, nine of these water wells are monitored by CNS (Table 3-2).

Monitoring results are submitted to DHEC on a quarterly basis in the form of two reports, the CNS Site Operational Monitoring Report and the CNS Environmental Monitoring Report.

Table 3-2

Barnwell Site Monitoring Program Sample Collection Schedule

Sample Description	# of Loc[1]	Type	Media	Frequency	Analysis
On-Site Locations:					
Monitor Wells[2]	106	Grab	Water	Quarterly	Gross Alpha/Beta, Gamma Isotopic, Tritium, C-14[4], pH, Conductivity, Temperature
Observation Sumps[2]	151	Grab	Water	Quarterly	Gamma Isotopic & Tritium
External Gamma	32	Continuous	TLD	Quarterly	Exposure
Site Boundary Locations:					
Wells[2]	28	Grab	Water	Quarterly	Gross Alpha/Beta, Gamma Isotopic, Tritium, C-14[5], pH, Conductivity, Temperature
Soil	11	Grab	Soil	Annually	Gamma Isotopic, Tritium
Vegetation	11	Grab	Vegetation	Annually	Gamma Isotopic, Tritium
Atmospheric	11	Continuous	Particulate Filter	Bi-Weekly	Gross Alpha/Beta, Gamma Isotopic
External Gamma	64	Continuous	TLD	Quarterly	Exposure
Off-Site Locations:					
Potable Wells[3]	9	Grab	Water	Annually	Gross Alpha/Beta, Gamma Isotopic, Tritium, pH, Conductivity, Temperature
Monitor Wells[2,3]	83	Grab	Water	Quarterly	Gross Alpha/Beta, Gamma Isotopic, Tritium, C-14[6], pH, Conductivity, Temperature
Surface Water[8]	8	Grab	Water	Quarterly	Gross Alpha/Beta, Gamma Isotopic, Tritium, C-14[7], pH, Conductivity, Temperature
Soil[8, 9]	5	Grab	Soil	Annually	Gamma Isotopic, Tritium
Vegetation[8,9]	5	Grab	Vegetation	Annually	Gamma Isotopic, Tritium
Sediment[8]	4	Grab	Sediment	Annually	Gamma Isotopic, Tritium
Atmospheric[9]	1	Continuous	Particulate Filter	Bi-Weekly	Gross Alpha/Beta, Gamma Isotopic
External Gamma	10	Continuous	TLD	Quarterly	Exposure

[1] As of June 27, 2005

[2] Water levels measured quarterly

[3] Selected wells sampled quarterly

[4] At 15 wells annually, Gross-Alpha Beta is used as a surrogate for C-14

[5] At 3 wells annually, Gross-Alpha Beta is used as a surrogate for C-14

[6] At 10 wells annually, Gross-Alpha Beta is used as a surrogate for C-14

[7] At 2 locations annually, Gross-Alpha Beta is used as a surrogate for C-14

[8] Off-Site Springs and Creeks:

[9] Barnwell County Airport

3.4.2 Non-Radiological Monitoring Program

CNS monitors non-radiological compounds in groundwater. The current non-radiological program is summarized in Table 3-3. Samples are collected by CNS and provided to an independent laboratory for analysis. Upon receipt of the laboratory results, CNS prepares a non-radiological monitoring report which presents results and data review. This report is sent to DHEC for information.

Table 3-3
Barnwell Site Non-Radiological Groundwater Sample Schedule

Sample Description	# of Locations	Type	Media	Collection Frequency	Analysis[1]
Wells	16	Grab	Groundwater	Quarterly	pH, Conductivity, Total Organic Carbon, Volatile Organics, Library Search
Stream	2	Grab	Surface water	Quarterly	pH, Conductivity, Total Organic Carbon, Volatile Organics, Library Search
Wells	12	Grab	Groundwater	Quarterly	pH, Conductivity, Total Organic Carbon, Chloroform
Wells	16	Grab	Groundwater	Annually	pH, Conductivity, Total Organic Carbon, Volatile Organics, Library Search, Acids, Base/Neutrals, Pesticides/PCB's, Cyanide, Phenols, Carbon-14
Stream	2	Grab	Surface water	Annually	pH, Conductivity, Total Organic Carbon, Volatile Organics, Library Search, Acids, Base/Neutrals, Pesticides/PCB's, Cyanide, Phenols, Carbon-14
Wells	12	Grab	Groundwater	Annually	pH, Conductivity, Total Organic Carbon, Volatile Organics, Library Search

1. Volatile Organics, Metals, Acids, Base/Neutrals, Pesticides/PCB's, Cyanide, and Phenols selected based on lists given in EPA, 1992. Carbon-14 is collected annually at non-radiological monitoring points.

4.0 WASTE PROJECTION SUMMARY

Waste disposal and land use projections for the next ten years are summarized in this section. A ten year period is assumed to be consistent with the time frame required by §48-46-40(B)(6) of the 1976 SC Code of Laws (as amended) for the Least Cost Operating Plan (CNS, 2004). In FY 2008/2009, CNS will begin in-region-only operations, during which waste may be received only from the three states of the Atlantic Compact. CNS expects in-region-only operations to continue for up to thirty years.

4.1 Waste Volume and Characteristics

Waste volumes and characteristics are primary factors affecting disposal facility planning. These data directly impact the cost of disposal operations as well as trench design, construction and closure schedules.

§48-46-40 (B)(6) of the SC Code of Laws (as amended) establishes limits on waste volume that can be received at the disposal site for the three years of disposal operations between FY 2005/2006 and 2007/2008. For this time period, CNS assumes waste receipts at the maximum allowed levels. The last seven years of the 10-year projection period differ in that waste may be received only from within the Atlantic Compact region. For this period, CNS estimates annual average waste receipts at 8,000 cubic feet (as shown in Table 4-1). It is recognized that annual volumes may vary, especially in later years, to support decommissioning activities within the compact.

Table 4-1
Projected Radioactive Waste Volumes

Fiscal Year	Maximum Allowed Volumes by Statute	Projected Waste Volume (ft^3)	Number of Slit Trench Shipments
2004/2005	50,000	42,000	24
2005/2006	45,000	38,800	19
2006/2007	40,000	37,200	18
2007/2008	35,000	32,000	20
2008/2009	NA	8,000	6
2009/2010	NA	8,000	6
2010/2011	NA	8,000	6
2011/2012	NA	8,000	6
2012/2013	NA	8,000	6
2013/2014	NA	8,000	6
2014/2015	NA	8,000	6

In Table 4-1, CNS has separately listed the projected number of slit trench shipments. These shipments, although representing a small fraction of total waste volume, require significant resources for cask handling and disposal. Slit trenches are small trenches for which the construction schedule is determined by the projected number of shipments rather than volume.

4.2 Projected Trench Construction and Site Use

The projected volumes in Table 4-1 have been used along with data on recent trench usage in Table 4-2 to estimate trench construction requirements and land use for FY 2005/2006 through 2007/2008. In Table 4-2, the percentage of waste disposed in Class A versus B/C trenches does not correspond to volumes of Class A and B/C wastes received because both classes are disposed in each trench depending on dose rate. CNS is currently performing disposal operations in Trenches 86, 94 and Slit Trench 25. B/C Trench 97 has been constructed but active disposal operations have not begun in this trench as of June 2005.

Table 4-2
Waste Volume Buried by Trench (in ft^3)

	A Trench		B/C Trench		Slit Trench		Total Volume[1]
	Volume	%	Volume	%	Volume	%	
CY 1998	124,740	63.7%	69,805	35.7%	1,139	0.6%	195,684
CY 1999	121,980	73.2%	42,945	25.8%	1,510	0.8%	166,435
2000 (Jan - June)	54,981	79.4%	13,331	19.3%	885	1.3%	69,197
FY 00/01	81,345	67.7%	36,296	30.2%	2,530	2.1%	120,171
FY 01/02	39,845	60.2%	25,733	38.9%	574	0.9%	66,152
FY 02/03	44,707	66.0%	22,148	32.7%	860	1.3%	67,715
FY 03/04	37,078	58.7%	24,734	39.2%	1,325	2.1%	63,137

[1] Total volumes buried.

During the next three years, CNS anticipates needing nearly 900 feet of slit trench based on current disposal efficiencies. Four new slit trenches will be required to accommodate the projected number of shipments. CNS will not require a new Class A nor B/C style trench. Current active Class A Trench 86, B/C Trench 94 and B/C Trench 97 will provide sufficient disposal space for projected Class A and B/C waste. Future trench locations are shown on Drawing B-500-D-300. The total area

required for new trenches constructed over the next three years is expected to be less than one-half acre.

During the in-region-only period, CNS anticipates shifting disposal operations to the large contiguous area designated as in-region operations area on Drawing B-500-D-300. Further evaluations will be required prior to selection of optimal trench designs for use during the in-region-only operations period.

4.3 Remaining Site Capacity

The Barnwell site licensed disposal area is divided into different use categories, as shown on CNS Drawing B-500-D-300 and summarized in Table 4-3 below.

Table 4-3
Barnwell Site Land Designations

Designation	Acreage
Licensed Disposal Area	235
Area Used for Disposal Since 1971	105
Future Trench Area	10
Other Leased Property (including buffer zone, water basins, ancillary operations and other areas currently unsuitable for disposal)	120

As of July 1, 2005, CNS estimates remaining disposal site capacity at approximately 2.58 million cubic feet. To estimate current remaining capacity, CNS reduced its official 1999 estimate by the waste volume disposed since that time. A full re-evaluation of remaining disposal capacity will be completed by the end of 2006. A re-evaluation is required to incorporate the potential impacts of (1) current and projected waste type distributions received, (2) anticipated design changes for low volume site operations and (3) current operational efficiencies.

5.0 ENVIRONMENTAL CHARACTERIZATION

This section summarizes CNS' current understanding of disposal site environmental conditions. Particular emphasis has been placed on describing and understanding the site's geology and hydrology because groundwater is the primary pathway for radionuclide migration to the general public.

5.1 Previous Environmental Assessments

On an ongoing basis during the lifetime of the Barnwell site, CNS, its contractors, and independent groups have studied the environmental characteristics of the Barnwell site. Several of the most significant evaluations are described below.

5.1.1 Environmental Assessments

Several comprehensive environmental assessments have been performed at the site, one of which was the Environmental Assessment for Barnwell Low-Level Radioactive Waste Disposal Facility (CNS, 1980), prepared and published by CNS in 1980 in response to a request from DHEC. This document is an assessment of expected and observed environmental and socioeconomic impacts from operation of the Barnwell site.

A second assessment was conducted by the NRC in response to a January 29, 1980, request by DHEC for technical assistance. The NRC office of Nuclear Material Safety and Safeguards (NMSS) produced NUREG-0879, Environmental Assessment for the Barnwell Low-Level Waste Disposal Facility (NRC, 1982). Although South Carolina is an Agreement State and therefore has licensing authority for low-level waste disposal in South Carolina, the State's actions in this regard are not within the purview of the National Environmental Policy Act (NEPA) of 1969. Consequently, a formal environmental impact statement has never been prepared on the Barnwell site. The NMSS assessment satisfied the DHEC request for an environmental assessment, and also served as a response to two other inquiries: (1) a General Accounting Office (GAO) report

to Congress questioning the ability of existing commercial sites to retain radioactive wastes and (2) a House Government Operations Committee recommendation aimed at improving the performance of LLRW sites.

NRC staff recommended continued operations with due consideration given to the staff's recommendations. The staff believed that implementation of their recommendations would improve the short- and long-term overall effectiveness of the Barnwell site. These recommendations were considered and incorporated into on-going site operation and environmental monitoring practices at the Barnwell site, as appropriate.

5.1.2 Disposal Site Characterization History Summary

In 1969, the first detailed site evaluations were performed as part of the original licensing phase for the Barnwell site. The geologic and hydrological findings are described in Law, 1971. No additional detailed evaluations were conducted until after tritium was detected outside disposal trenches in the late seventies. As a result of this finding, CNS increased its level of environmental characterization and monitoring, and initiated additional site studies. In 1982, the USGS published a comprehensive study of the site geology and hydrology, including an assessment of the extent of tritium (Cahill, 1982). The site stratigraphy and lithologic interpretation (from the Cahill study) is provided in Figure 5-1. Other stratigraphic interpretations and nomenclature are discussed in Nystrom, *et al.,* 1991.

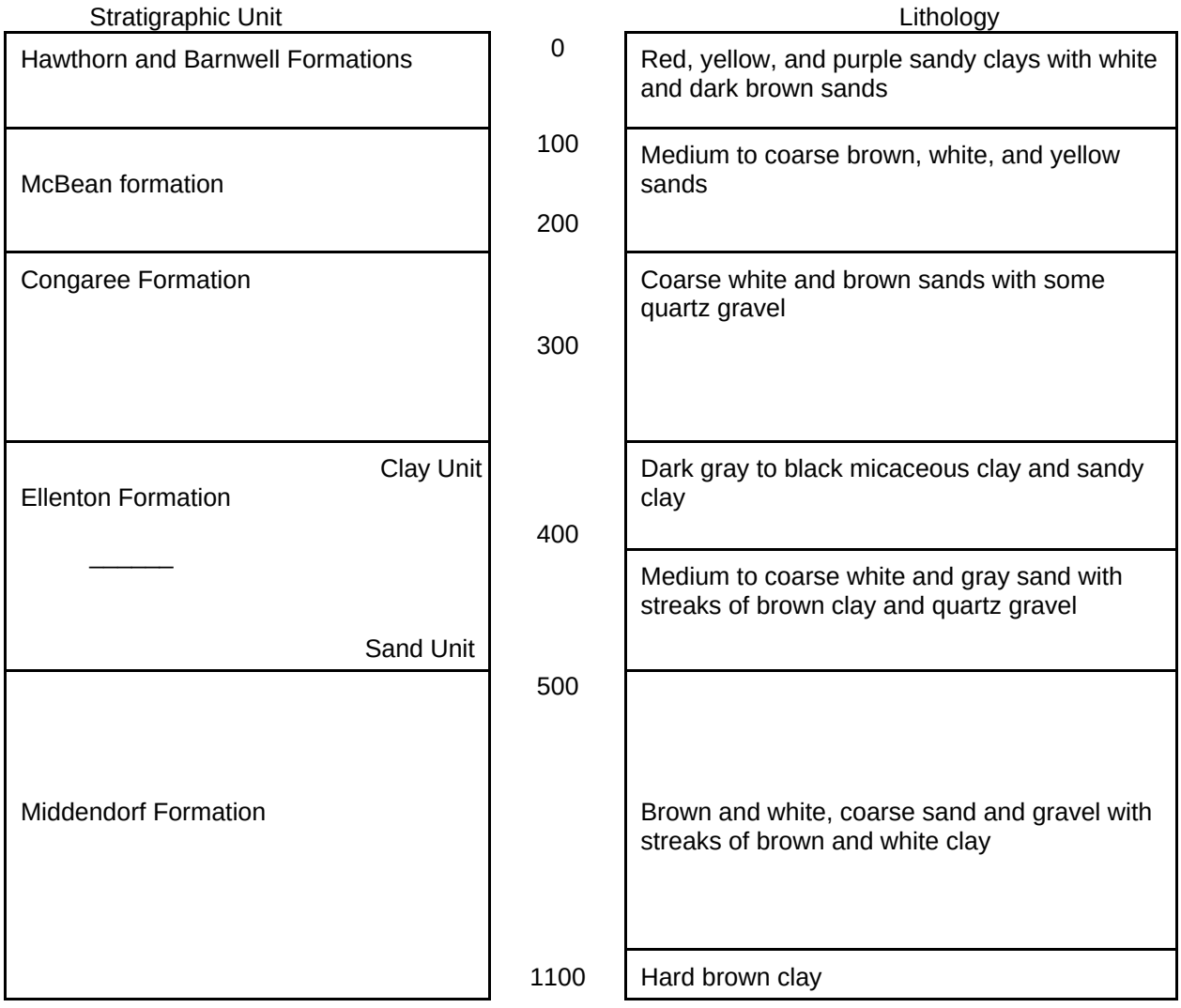
Since 1985, CNS has implemented several projects to further characterize site geology. CNS designed these studies to provide baseline characterization data for ground water modeling. Beginning in 1987, CNS expanded its focus to include evaluations of contaminant transport from the disposal site. These efforts by CNS in close coordination with DHEC are on-going.

Additional USGS studies published in 1987 characterized disposal site water balance (Dennehy and McMahon, 1987). USGS results

provide justification for recharge values used in CNS groundwater transport models.

FIGURE 5-1

Stratigraphic and Lithologic Interpretation of The Barnwell site
(Adapted from Cahill, 1982)



5.2 Groundwater Conditions

Annual precipitation at the burial facility is approximately 46 inches. Approximately 14 to 17 inches of precipitation per year are believed to recharge the groundwater on the Barnwell site (Dennehy and McMahon, 1987). The available moisture and the hydraulic conductivity of the near-surface sediments control groundwater recharge. Once moisture leaves the near surface, it is free to drain to the water table. To minimize groundwater recharge over the disposal trench area, CNS has installed engineered trench caps.

Hydrological studies conducted by Cahill (1982) and CNS environmental monitoring data have shown that the shallow groundwater flow system near the burial facility can be separated into two zones. These two zones are traversed by groundwater, which originates at the burial site. Beneath the disposal site, Zone 1 extends from the water table (approximately 30 feet beneath the land surface) to approximately 70 feet beneath the land surface. Zone 1 is considered to be restricted to the high- fines (>10% fines) sediments of the Hawthorn and Barnwell Formations. Zone 2 is considered to occur in the low fines (<10% fines) sediments of the Barnwell Formation. The hydraulic conductivity of Zone 1 is less than the hydraulic conductivity of Zone 2. Groundwater that recharges on the site flows steeply through Zone 1 and then almost horizontally through Zone 2.

Typically, the water table rises and falls seasonally, reflecting the time variation of groundwater recharge. The results of the study conducted by Dennehy and McMahon (1987) have shown that precipitation exceeds evapotranspiration during the fall, winter and spring. This observation is reflected by the water table's maximum elevation occurring during the months of May to June.

The potential movement of radioactivity from the disposal trenches to an off-site location takes place over a long time. Therefore, CNS has used average water elevation data to predict the movement of radioactivity.

5.3 Water Table Conditions

CNS monitors the fluctuations in water table elevations beneath the Barnwell site by means of a set of monitoring wells screened in ground-water Zone 1. One of the primary reasons for monitoring water table elevation is Condition 97g of License 097, which requires that the bottom of a disposal trench be designed to be at least five feet above historical high water table elevations in the immediate area.

Although CNS constructs disposal trenches at least five feet above the horizontal high water table, there have been high water table elevations exceeding historical highs. These high water table elevations, which last a few months, were above the bottom of the trenches in selected areas. However, high water tables do not appear to significantly affect the movement of radioactivity in groundwater.

5.4 Environmental Conditions

In CNS' groundwater sampling program, tritium, carbon-14 and technetium-99 have been detected in downgradient groundwater monitoring wells. Tritium is the only radionuclide detected in significant concentrations. The concentrations of carbon-14 in monitoring wells are generally low; however, the area distribution appears to be similar to tritium. Technetium-99 has been measured at low concentration at one location downgradient of the Phase 3 enhanced cap.

To address tritium concentrations, CNS has added enhanced trench covers designed to essentially eliminate infiltration from the surface. The elimination of infiltration should eliminate further tritium contribution to the groundwater from existing trenches. Trench cap designs and locations are described in Section 6.2.1.

CNS has estimated maximum radiological dose rates to any member of the public by direct measurements and models and summarized these evaluations in the Environmental Radiological Performance Verification (ERPV) report (CNS, 2003). The ERPV projects current environmental

measurements to estimate peak dose rates at a compliance point located at the CNS property boundary. In its performance modeling of the site, CNS has evaluated the groundwater, surface water and air pathways, the primary means by which radioactivity could reach any member of the public after the disposal site closes.

Tritium, carbon-14, chlorine-36, iodine-129, neptunium-237 and technetium-99 are radionuclides that can reach the compliance point within a 2000 year time period through the groundwater pathway. The maximum concentration of measured tritium, carbon-14 and technetium-99 at groundwater monitoring points are projected to the compliance point using a groundwater and stream flow model.

The result of the ERPV shows the maximum projected hypothetical dose rate at the compliance point is 13 mrem per year total effective dose equivalent (TEDE) with most of the dose from tritium. Carbon-14 and technetium-99 are expected to contribute much less than 0.2 mrem per year.

The maximum hypothetical dose rate based on current environmental measurements is 5.7 mrem per year from tritium at the compliance point. Carbon-14 and technetium-99 are below detection limits. Since there is no known consumer of water in the vicinity of the compliance point, the actual dose rate is negligible.

To address contingency at the compliance point, CNS has provided SCDHEC with an estimate to perform groundwater treatment near the headwaters of Mary's Branch. The financial analysis for this contingency is provided in Section 8.5.

CNS' air pathway analysis assumed potential emission of gases containing radioactivity due to decomposition of waste. To address gases, attempts were made to measure radionuclides in air in the breathing zone when soil gas concentration is expected to be maximum. Other than naturally-occurring radon gas, no gaseous radioactivity was detected on

the disposal area. Therefore, no dose to any member of the public adjacent to the disposal site is expected from radioactive gases.

As part of the site closure and post-closure observation, CNS will provide DHEC with updated environmental reports and site performance evaluations, which will show the status of the environment on and beneath the surface of the site. The latest groundwater monitoring data will be incorporated into these evaluations.

6.0 INTERIM SITE STABILIZATION AND CLOSURE PLAN

The Interim Site Stabilization and Closure Plan (Closure Plan) embodied in Section 6 provides a framework and plan for activities aimed at achieving site stabilization. In this plan, CNS identifies tasks required to complete closure of the disposal facility, provides cost and schedule projections, and summarizes closure activities completed to date. Closure activities detailed in this plan have been selected and designed to meet or exceed closure performance objectives. Components of the plan are summarized below and detailed in this and subsequent sections.

Section 6.0 is divided into several subsections. The five primary subsections are (1) facility decontamination and decommissioning, (2) site stabilization, (3) environmental monitoring, (4) performance assessment and (5) closure cost and schedule. Descriptions in Section 6 are focused on activities anticipated to occur up to and during the 15-month Phase I closure period FY 2008/2009 and 2009/2010. A separate section describes the second closure period (Phase II) following in-region operations. Decommissioning work planned during Phase I closure is summarized below.

Facility decontamination and decommissioning involves radiological survey, decontamination (as required) and disposition of structures and adjacent areas on State property. Some structures will be dismantled and disposed on-site, while others will be retained for in-region operations and ultimately custodial use. CNS will also perform a closed-site survey to demonstrate that radiation above trenches is essentially background.

Primary elements required to ensure long-term site performance and stability consist of site stabilization activities such as enhanced capping, final grading and surface water management. As this plan demonstrates, CNS has designed the final closed facility to minimize erosion, control runoff and limit infiltration into disposal trenches, all in an effort to ensure performance objectives will be met through in-region-operations, institutional control and beyond.

Closure period environmental monitoring is specified in Section 6.5 of this plan. During Phase I closure, CNS plans to update and finalize site performance assessment for closed site areas. This activity will incorporate all appropriate

disposal, site characterization and environmental monitoring data into a final evaluation and projection of facility performance. As discussed in Section 6.9, certain related activities may be performed before the closure period.

In this plan, CNS has identified required closure activities, associated costs and schedules. More than three-fourths of the existing disposal area has been fitted with enhanced caps and is already in its final closure configuration. Other closure activities are planned to occur in conjunction with on-going waste disposal operations during the next three years. These activities are financed from the decommissioning trust fund. This approach allows CNS to optimize the use of existing personnel and other resources at the site while minimizing decommissioning costs.

For the purposes of this plan, the Phase I closure period is assumed to begin concurrent with the start of in-region-only operations and to be completed within 15 months. It is also assumed that all closure tasks, associated support functions and site maintenance and monitoring functions will be paid from the decommissioning trust fund. Immediately following completion of closure activities, CNS will transition to post-closure observation. Phase I post-closure and long-term care activities are discussed in Section 8, and will be paid first from remaining monies in the decommissioning trust fund and then from the long-term care fund. CNS assumes in-region-only operations will last 30 years, followed by the Phase II closure and post-closure observation periods. The 100-year institutional control will begin following Phase II post-closure. Phase I closure activities, costs and schedules are provided in Sections 6.1 through 6.10. Phase II closure is discussed in Section 6.11. Closure financial assurance is discussed in Section 6.12.

6.1 Facility Decontamination and Decommissioning

6.1.1 Building and Equipment Decontamination and Decommissioning

The buildings at the CNS Barnwell site are described in Section 3.3. A plan for disposition is provided for only the structures that are within the proposed State property boundary. These structures will be surveyed and decontaminated as necessary for their intended use. Structures will either remain for later use for disposal

site related activities or be dismantled and buried on-site. Equipment and materials not needed for subsequent activities will either be released from the site for disposition or buried on-site (as appropriate).

The results of routine surveys for direct radiation and contamination levels in each building and their associated components have been used to determine current radiological status of these structures. Based on current radiological conditions, those structures to be removed will be dismantled in accordance with the precautions and methods described below.

The proposed disposition of each structure on State property is summarized in Table 6-1. Only the Cask Maintenance Building is proposed to be retained as a post-closure and long-term care facility. Those showing a disposition of "dismantle" will be decommissioned during the Phase I closure period and either released from or buried on-site. The costs of dismantlement of buildings not associated with disposal operations will not be paid from the decommissioning trust fund. A summary of the radiological status for site structures is given in Table 6-2. A summary of the radiological status of components that are used in these buildings is provided in Table 6-3.

CNS interviewed long time site employees and reviewed incident reports to research the history of contamination events in or around site structures. CNS identified several historical spill events through this process. CNS found, for the most part, that these spills were remediated at or near the time of occurrence. CNS expects, based on its interviews and recent characterization efforts, some soil contamination in the area around the Site Operations Maintenance Building, due to early site operations. This area is identified for further characterization and remediation, as required.

Table 6-1
Site Structures

Number[1]	Name	Disposition
2	Receiving Warehouse No. 2	Dismantle[2]
3	Warehouse No. 3	Dismantle[2]
7	Liner Operations Building	Dismantle[2]
8	Site Building	Dismantle
10	HP Building	Dismantle
11	Site Operations Maintenance Building	Dismantle
13	Cask Preservation Building	Dismantle
14	Cask Maintenance Building	Retain
15	Field Services Maintenance Warehouse	Dismantle
16	Grounds Maintenance Shop	Dismantle
19	Drilling Equipment Storage Trailer	Dismantle

[1] The numbers are keyed to CNS Drawing B-500-D-300.
[2] These buildings will be dismantled and dispositioned with funding independent of the decommissioning trust fund.

Table 6-2
Site Structures – Radiological Status as of May, 2005*

Number	Name	Removable Contamination	
		Maximum dpm/100cm^2 Beta/gamma	Mean mrem/hr
2	Receiving Warehouse No.2	<200	0.06
3	Warehouse No.3	<200	0.06
7	Liner Operations Building	<200	0.08
8	Site Building	<200	0.06
10	HP Building	<200	0.06
11	Site Operations Maintenance Building	<200	0.08
13	Cask Preservation Building – Washdown	<200	0.06
13	Cask Preservation Building – Sandblast	500 Note 1	0.1 Note 1
14	Cask Maintenance Building	<200	0.06
15	Field Services Maintenance Building	5000	5.0
16	Grounds Maintenance Shop	< 200	0.06
19	Drilling Equipment Storage Trailer	< 200	0.06

* Survey data based on 6 months' data retrieved from routine surveillance surveys conducted in accordance with CNS procedures.
Note 1 – removable contamination and mean mrem/hr vary due to on-going work in building

Table 6-3
Site Structures – Components Radiological Status

Name (Number)	Components	Ducts	Pipes	Drains	Tanks
Receiving Warehouse No.2 (2)	<200 dpm/100cm^2	None	Potable water supply	None	None
Warehouse No.3 (3)	<200 dpm/100cm^2	Ventilation system - <200 dpm/100cm^2	None	None	None
Site Building (8)	<200 dpm/100cm^2	Ventilation system - <200 dpm/100cm^2	Potable water supply	Sanitary sewer drains & decon sink drain - <200 dpm/100cm^2	sanitary sewer septic tank - <200 dpm/100cm^2
Cask Preservation Building (13)	<200 dpm/100cm^2	2 Separate HEPA Systems (1 abandoned/1 in use)	Air Supply	Abandoned floor drain/sump	10,000 gallon tank from truckwash <200 dpm/100cm^2
Cask Maintenance Building (14)	<1000 dpm/100cm^2	None	Air Supply/ Floor Drain	Floor Drain (1) - <200 dpm/100cm^2	1 Buried HIC - <200 dpm/100cm^2
Grounds Maintenance Shop (16)	<200 dpm/100cm^2	None	None	None	None
Drilling Equipment Storage Trailer (19)	<200 dpm/100cm^2	Ventilation System* <200 dpm/100cm^2	None	None	None

* New ventilation system - CNS has not surveyed the duct system; however, routine radiological surveys of the trailer have shown <200 dpm/100cm^2

Table 6-1 identifies ten structures to be dismantled and dispositioned, of which seven are to be funded through the decommissioning trust fund (as indicated on Table 6-1). CNS assumes dismantled structures will be disposed directly in site trenches without the use of concrete disposal vaults. However, prior to closure, specific criteria defining levels of contamination that are acceptable for this disposal practice will be established. The general radiological conditions and proposed decommissioning methods for each building and area are discussed below.

The Cask Preservation Building is expected to have contamination on portions of the walls and floor. The floors, walls and other interior surfaces will be surveyed in accordance with approved CNS radiological control procedures. Areas with contamination levels greater than 50 dpm/100 cm^2 alpha and/or 1000 dpm/100cm^2 beta/gamma will be identified. Those surface areas with identified contamination levels will have the contamination fixed in place prior to dismantling. The concrete floor will be chipped up, removed and disposed of appropriately. The HEPA filters and ventilation system will be removed and packaged for disposal, as appropriate. Building demolition, rubble and soils will be placed directly into an approved disposal trench.

The Field Services Maintenance Building and the Site Operations Maintenance Building have been associated with radiological work and will be considered suspect for contamination. The buildings will be surveyed to the radiological limits above and then dismantled as clean rubble for disposal. Any contaminated areas found above limits will be fixed and the material properly disposed.

The remaining four buildings, Site Building, HP Building, Grounds Maintenance Shop and Drilling Equipment Storage Trailer historically have had very minor, if any, contamination involvement. These facilities will be surveyed to the same standard as the other three buildings, dismantled and the resultant wastes placed in a disposal trench. The concrete slab at the Site Building will be broken up and disposed of in a disposal trench. The soils under

the Site Building, HP Building and Drilling Equipment Storage Trailer will be surveyed to ensure that any remaining contamination is below levels requiring excavation. The concrete pad of the Grounds Maintenance Shop is part of the Cask Maintenance Building and will be surveyed to ensure that any remaining contamination is below levels of concern and left in place as part of the Cask Maintenance Building.

Since contaminated equipment has been historically serviced and stored around the Site Operations Maintenance Building, Field Services Maintenance Warehouse and Cask Preservation Building, CNS plans radiation surveys of the ground surfaces in these areas. Radiation surveys of the ground surfaces will occur after stored equipment has been moved and the buildings are dismantled. Radiation surveys will include collecting surface soil samples on 10-meter grid and four shallow borings to the water table.

The volume of site-generated waste that will be produced during facility and equipment decommissioning is conservatively estimated to be approximately 40,000 cubic feet of building rubble and 26,000 cubic feet of soil. Based on the levels of contamination and nature of decommissioning waste (rubble, soil), these materials will be buried in remaining portions of active trenches. Decommissioning waste disposal locations will be determined at closure. The decommissioning rubble and soil will be transferred to the trench in dump trucks.

CNS anticipates that approximately 20,000 yd^3 of backfilling will be required for the layering of building rubble and for closure of remaining active trenches. If space is not available in active trenches for projected decommissioning disposal volume, then CNS will construct a decommissioning trench sized for the estimated 66,000 cubic feet (approximately 2,400 cubic yards) of decommissioning waste.

6.1.1.1 Contamination Control Provisions

Characterization surveys of the structures will be performed before dismantlement begins. Based on recent surveys, the buildings being dismantled do not have high levels of removable contamination, and the levels on the building components are less than allowed on waste packages by DOT regulations.

To minimize the potential for spreading contamination during transport and offloading, the building rubble may either be misted with water or a fixative to prevent the generation of dust or transported in covered dump trucks.

The Cask Maintenance Building will be surveyed and decontaminated. The metal walls will be decontaminated to acceptable levels. Any contamination exceeding the applicable limits on the concrete floor will be chipped up and removed.

Routine surveillance surveys indicate that the Cask Preservation Building has the potential to cause significant radiation exposure due to the levels of removable contamination found on most interior surfaces. This building has been used for abrasive decontamination of various site equipment, and removable contamination is found on most surfaces. The controls that will be used to prevent personnel contamination and airborne radioactive material include vacuuming surfaces and/or fixing the contamination in place prior to dismantlement. Personnel entry and activities will be monitored, and controls may include respiratory protection devices in addition to protective clothing. These activities shall be conducted in accordance with established CNS radiation protection procedures.

6.1.1.2 Site Equipment

There are approximately 70 pieces of heavy and light equipment on site. The equipment will be evaluated for existing value and potential for continued service. Radiological surveys will be performed to ensure that equipment is not contaminated. Decontamination techniques, such as abrasive grinding, wire brushing, wiping, decontamination washing, cutting-out of material and sandpapering may be used to remove contamination from accessible areas. Areas that are inaccessible will be evaluated by process knowledge to determine the potential for radiological contamination. If the potential exists and verification cannot be done, the equipment will be considered contaminated and dispositioned appropriately. Non-contaminated serviceable equipment will be surveyed and released from site for unrestricted use.

6.1.1.3 Safety Controls During the Building Dismantlement

Chem-Nuclear has thoroughly reviewed the potential health and safety hazards associated with dismantlement of site buildings and has identified appropriate control measures that will prevent personnel injuries. Regular surveillance of dismantlement activities will be performed by a CNS Safety Representative to ensure worker compliance with safe work practices and applicable company and Occupational Safety and Health Administration (OSHA) safety requirements. CNS will ensure that workers are appropriately trained to perform assigned tasks in a safe manner and that only certified heavy equipment operators are used.

6.1.2 Soil Survey and Characterization

The subsurface areas around all on-site buildings and lined holding ponds will be characterized to evaluate levels of radiological

contamination. The following surface and subsurface site characterization is planned:

* Surface gamma surveys on a 10-meter by 10-meter grid pattern.

* Surface soil samples on a 10-meter by 10-meter grid pattern at six- inch depth intervals analyzed for gamma radioactivity and tritium. One composite soil sample will be collected per grid.

* Deep soil sampling in areas around the Site Operations Maintenance Building, Cask Preservation Building and areas of known leaks or spills may occur to depths of as much as 80 feet. Samples will be analyzed for gamma radioactivity and tritium.

* Contaminated soil will be removed as part of closure and decommissioning. The amount of materials removed will depend upon the level of contamination. CNS anticipates minimal soil removal will be required.

6.1.3 Site Structures, Equipment and Soil Decommissioning Cost Summary

Table 6-4 lists the estimated costs of facility and equipment decommissioning activities. These costs assume no disposal taxes or surcharges applied to site-generated decommissioning waste.

Table 6-4
Structures and Equipment Decommissioning Costs

Preliminary Building Surveys	CNS Labor	$33,517
	Leased Equipment	$2,067
Building Dismantlement/Disposal	CNS Labor	$446,848
	Leased Equipment	$398,965
Soil Excavation	CNS Labor	$24,203
	Contractor	$7,500
	Leased Equipment	$19,880
Equipment Release	CNS Labor	$28,436
	Subtotal	$961,416
G & A Allocation		$57,685
	Subtotal	$1,019,101
Fee		$142,674
Total		$1,161,775

6.1.4 Closed-Site Survey

In order to ensure that the direct gamma radiation from buried radioactive waste is essentially background and that any radioactive contamination at the surface of the site is less than concentrations found in appropriate regulatory references, an extensive soil sampling and survey program will be undertaken. The soil sampling and survey plan and data evaluation will be compatible with regulatory guidance, NUREG/CR-5849 (NRC, 1992) and MARSSIM (NRC, 2000).

In order to determine a background direct gamma radiation rate, data will be collected from background locations established in the site's environmental sampling program. A hand-held pressurized ionization chamber, or equivalent micro-R instrumentation, will be used to collect data from each of the identified background locations. The data will be compiled to obtain an average background radiation rate.

Approximately 153 acres of the site will be included in the final site survey. These 153 acres include disposal trench covers, approximately 50% of buffer area, and the area of the Site Maintenance Shop, Field Services Building and Cask Preservation Building after building and slab removal. The 153 acres will be divided into grid blocks approximately 50 meters per side and a minimum of 30 direct gamma readings will be obtained in each grid area. A single composite sample of surface soils, at a sampling depth of 0 to 6 inches, will be collected in each grid block. Additional surface soil sampling will occur at areas where the direct gamma readings indicate dose rates greater than the statistically derived background rate. Statistical data interpretation, compatible with regulatory guidelines will be applied to the data to demonstrate compliance with appropriate regulatory guidance.

Table 6-5 lists the costs of final site surveys. A report of all data and evaluations will be prepared and submitted to DHEC for their review and approval.

Table 6-5 Final Site Survey Costs		
Land Surveying	Contractor	$24,000
Direct Gamma Measurements, Soil Sampling	CNS Labor CNS Equipment	$55,824 $6,000
Soil Analysis (gamma, TPH)	CNS Labor	$20,849
	Contractor	$10,800
	Subtotal	$117,473
G & A Allocation		$7,048
	Subtotal	$124,521
Fee		$17,433
Total		$141,954

6.1.5 Physical Security

Security personnel will maintain a 24-hour-a-day schedule. Their duties include controlling entry and exit at site access locations, making daily security checks for intruders, and checking for lock tampering or evidence of forced entry at gate locations. Table 6-6 provides a cost estimate for site security.

A seven-foot high fence secures the licensed disposal area. The fence is galvanized steel mesh with three strands of barbed wire running parallel to the mesh and extending outward from the top for 18 inches at a 45° angle. Galvanized steel posts are inside the fence fabric and set in circular concrete anchor footings for stability. Horizontal rails along the top support the fence fabric and add bracing. The fence is checked for sagging, leaning, torn fabric, erosion or gaps underneath, fallen or leaning trees and loose or broken barbed wire. All discrepancies are noted and repairs are implemented as soon as possible.

Table 6-6 Site Security (15 Months)		
Site Security	CNS Labor	$334,958
	CNS Equipment	$30,500
	Subtotal	$365,458
G & A Allocation		$21,927
	Subtotal	$387,385
Fee		$54,234
Total		$441,619

CNS recommends adjusting the site property boundary to provide area adequate to maintain site stability. Fence will be re-located as necessary to encompass the closed site property boundary. Proposed licensed disposal area property boundary is discussed further in Section 6.7.

6.2 Site Stabilization

This section describes those closure activities directed at achieving final closure and stabilization of the disposal site. Disposal site stabilization is accomplished by installing enhanced caps on the remaining disposal trenches and designing efficient surface water management controls. CNS' goal is to establish site conditions that eliminate, to the extent practicable, the need for on-going active maintenance during institutional control so that only surveillance, monitoring or minor custodial care are required.

6.2.1 Disposal Area Closure

After waste burial in a disposal trench is complete and backfill installed, CNS completes trench closure by installing an enhanced trench cap. CNS first started installing enhanced caps on certain older trenches in 1991. Enhanced cap construction became a routine part of disposal trench construction procedures in 1995. CNS plans to continue capping existing trenches and, at closure,

will cap all remaining trenches. Design, construction costs and schedule for capping are discussed in subsequent sections.

6.2.1.1 Enhanced Cap Design

The CNS enhanced cap consists of multiple layers of earthen and geosynthetic materials, specifically selected to minimize infiltration. Cap layers are (from bottom to top) compacted clayey sand; bentonite mat; high-density polyethylene (HDPE) geomembrane; sand drain layer; and general soil cover. The function of each component is described below.

The HDPE, bentonite mat and clayey sand comprise the vertical barrier to water infiltration. The overlying sand drain directs water percolating through the soil cover laterally to the perimeter of the cap where it drains as surface runoff away from the capped trench area. The soil cover protects the drain and barrier layers from erosion and other physical/chemical effects and supports vegetation growth. Vegetation protects the cap surface from erosion and contributes to water removal through transpiration. All cover components and the concrete disposal vaults below work together to ensure the long-term integrity and performance of the disposal trench.

The surface configuration and geometry of each cap area are unique, controlled by such factors as trench top elevations, sizes of trenches and runoff drainage requirements.

6.2.1.2 Cap Enhancement Projects (1991 to 2005)

As of 2005, CNS has completed approximately 96 acres of enhanced cap, covering 80 trenches (locations shown on CNS Drawing #B-500-D-300). All construction phases to date have primarily involved older closed trenches (previously covered with compacted clay and soil materials). Data for each capping phase including date of

completion, covered area, construction cost and number of trenches involved are included in Table 6-7 and summarized below.

TABLE 6-7
HISTORICAL ENHANCED CAPPING SUMMARY

Phase	Date of Completion	Acres	# of Trenches Covered	Approximate Cost ($ in Millions)
1	1/92	12.5	20	1.7
2	2/94	8	10	1.4
3	7/95	26	12	4.1
4	5/97	22.5	14	3.0
5	9/98	10	9	1.65
6	5/04	17	15	2.9
Total		96	80	14.75

CNS completed the first enhanced cap in 1992 on the earliest site trenches located in what was termed the “Old Southern Trench Area.” This cap (Phase I) involved 20 trenches and approximately 12.5 acres. Phase I cap design was identical to all subsequent caps, except HDPE geomembrane thickness (40 mil) and height of protective toe drain stone were less. CNS has since changed the height of protective toe drain stone on the Phase I cap to current standards, improving erosion protection.

Phase 2 cap, completed during 1994, covered 10 trenches and approximately eight acres. For Phase 2, HDPE geomembrane thickness was increased from 40 mils to 60 mils, simplifying geomembrane installation because the greater thickness is easier to seam and wrinkles less. This area, like Phase I, includes mostly early (pre-1980) trenches, completed before many of the waste form improvements of the 1980’s.

Phase 3 cap, completed during 1995, covered 12 trenches and approximately 26 acres. The Phase 3 cap area

consists of 1000-foot long trenches, which were completed in the late 1970's and early 1980's. The cap design is similar to that used for Phase 2, except the large cap size led to the inclusion of surface drainage swales within the cap perimeter. These swales collect and direct surface runoff and internal sand drain percolate to the edge of the capped area.

Phase 4 cap, completed during 1997, covered 14 trenches and approximately 22 acres. The Phase 4 cap area consisted of larger more recent Class A trenches and a few slit trenches, all completed during the 1980's. The cap design is very similar to that used for Phase 3, including the use of internal surface drainage swales. The southwest edge of Phase 4 was left incomplete as a tie-in for the Phase 5 cap, planned immediately to the south.

Phase 5 cap, completed during 1998, tied directly to Phase 4 cap to the north, thereby providing continuous cap coverage between contiguous construction phases. Phase 5 covered nine trenches and approximately 10 acres. Phase 5's internal swales originated in and were an extension of swales built during the Phase 4 cap construction.

Phase 6 cap, which was completed during 2004, is divided into two areas, a north and south site. The north site is adjacent to the east side of the Phase 4 cap. The south site is near the west side of the Phase 3 cap. The total area covered was approximately 17 acres.

6.2.1.3 Future Enhanced Cap Construction

Between 2005 and the end of Phase I Closure, CNS plans to install approximately 22 acres of enhanced cap covering all remaining non-capped trenches anticipated to exist by this time. Cap designs are anticipated to remain essentially the same as described in Section 6.2.1.1. The projected cap enhancement costs in Table 6-8 are based

on actual Phase 6 cap enhancement construction costs. Cap construction estimates include design and construction costs as well as G&A and fee.

Table 6-8
Phase I Closure Enhanced Capping Schedule

Cap Phase	Construction Start Date	Area (Acres)	Estimated Cost		G & A Allocation	Fee	Total Estimated Cost
7	2007	3.6	CNS Labor	$18,104			
			Contractor	$437,380			
			Material	$116,828			
			Subtotal	$572,312	$34,339	$84,931	$691,582
8	2008	5.9	CNS Labor	$30,173			
			Contractor	$718,299			
			Material	$176,995			
			Subtotal	$925,467	$55,528	$137,339	$1,118,334
9	2009	12.9	CNS Labor	$69,397			
			Contractor	$1,558,654			
			Material	$401,316			
			Subtotal	$2,029,367	$121,762	$301,158	$2,452,287
Total		22.4		$3,527,146	$211,629	$523,428	$4,262,203

6.2.2 Surface Water Management

Surface water management is comprised of three primary elements: final site topography, drainage pathways and ponds. These elements are combined in the closure surface water management and final topography drawing (Figure 6-1), which includes site topographic and surface drainage features.

Since 1991, CNS has made significant progress towards achieving final grades on the site by constructing approximately 96 acres of enhanced cap. Each enhanced cap has been designed and graded to closure grades and planted in grass. Most non-trench areas are currently at or near final grade except parts of the site currently designated for closure water management holding ponds. CNS believes that contouring the site to final grades, constructing properly sized water management ponds, and establishing a healthy grass cover will minimize long-term site maintenance requirements and assure site stability. The following sections

describe the proposed surface water management system and final topography.

6.2.2.1 Surface Water Management Ponds

CNS has begun reconfiguring the site, including constructing water management ponds and surface water conveyances, to handle runoff expected from the closed disposal site. CNS has proposed two closure retention ponds to manage stormwater from the two primary watersheds draining the disposal site.

The primary pond design criteria are (1) adequate separation of pond areas from disposal trenches and (2) sizing the ponds for high on-site capacity and controlled off-site flows.

To evaluate potential runoff volumes, the disposal site has been divided into drainage areas. Most of the site (~185 acres) drains west to the new west water management pond. The southeast portion of the site (~44 acres) currently drains to a small detention pond on the southeast corner of the site.

The west water management pond has been constructed by removing the berm between the pre-existing north and south ponds and the low area immediately east of the ponds and extending pond area west onto CNS property. Fill has been placed on the north and east sides of this low area to provide additional separation of pond areas from disposal trenches. An overflow has been located on the south end of the new pond to direct water to additional water management features off-site. The overflow elevation ensures water does not back-up on surrounding trenches while also providing significant on-site storage. The capacity of the new pond exceeds the volume of runoff produced by a 100-year 24-hour storm, ensuring no routine

surface water discharge from the west side of the site. West pond construction started in 2004 and approved interim elevations were completed in 2005. Final west pond elevations will be completed during Phase I closure.

The planned southeast water management pond will be constructed by enlarging the current sediment detention pond located at the southeast corner of the site. Constructing this basin should primarily involve excavation. The pond configuration shown on Figure 6-1 and construction costs are estimated based on the DHEC-approved west pond specifications and costs. Final pond location and size will be determined through detailed design and analysis, as well as regulatory review. The pond will consist of a permanent pool that will evaporate and percolate and a portion that will drain through appropriate flow structures off-site. The design will also include emergency spillway provisions. The water that drains from the pond will discharge onto adjacent CNS property east of the site and infiltrate into sandy, well-draining native soils. The design effort will involve analyzing surface water drainage conditions anticipated for the closed disposal facility, then using hydraulic modeling including Soil Conservation Service (SCS) methods to estimate runoff rates and volumes.

Pond construction costs are provided in Table 6-9. The estimated remaining earthwork volumes to complete proposed surface water management ponds are provided in Table 6-10.

Table 6-9 Pond Reconfiguration Costs		
West Pond Completion		
Construction	Contractor	$36,408
	CNS Labor	$4,702
	Materials	$31,383
	Subtotal	$72,493
G & A Allocation		$4,350
	Subtotal	$76,843
Fee		$10,758
	Subtotal	$87,601
Southeast Pond		
Design / Construction	Contractor	$240,997
	CNS Labor	$17,103
	Materials	$10,800
	Subtotal	$268,900
G & A Allocation		$16,134
	Subtotal	$285,034
Fee		$39,905
	Subtotal	$324,939
Total		$412,540

6.2.2.2 Final Topography

CNS has developed the final Barnwell site topography (Figure 6-1) to achieve: (1) surface contours to promote passive surface water management, (2) optimized sloping over trench areas to drain water efficiently away, while minimizing erosion; (3) efficient, cost-effective configurations that use materials wisely and fit with surrounding topography, and; (4) elevations that provide minimum five feet of earth over waste. The majority of the site (counting completed enhanced caps) is considered to be at final grade. For trench areas without enhanced cap and some other site areas, substantial amounts of earthmoving remain. These areas are discussed below.

For trench areas without enhanced cap, final grades will be determined and submitted for DHEC review and approval

as part of the specific design effort performed prior to construction of a new enhanced cap. Caps will be graded consistent with previous designs and the design goals listed above.

Currently, four non-trench site areas are anticipated to require significant grading to achieve final topography. The first is the ancillary facility area south of the new west pond. The second is the space remaining in active trenches after cessation of disposal and placement of decommissioning wastes. The third is on the southeast side of the site where a closure water management pond is proposed to be installed. The fourth is the final grading required to bring the west pond to final approved grades. Design and construction plans for closure water management ponds are described in Section 6.2.2.1.

After removal of all structures in the restricted area south of the west pond (except the Cask Maintenance Building), CNS plans to fill this area to drain west into the existing west swale. Most filling will occur on the west side of the low area, gently sloping the land surface to tie into existing grades west of the Phase I cap.

At closure, CNS anticipates that space may remain in disposal trenches, and such areas will need to be backfilled. Based on a review of projected waste disposal volumes and decommissioning waste volume estimates (Section 6.1.1), CNS anticipates remaining space in Trench 86 and B/C Trench 97, totaling as much as 20,000 yd^3.

The third area requiring significant grading is located on the southeast side of the site. At this location, CNS proposes to enlarge the current sediment detention pond to improve long-term management of runoff. Details are provided in Section 6.2.2.1.

The fourth area involves final grading of the west pond. The west pond is anticipated to require additional grading

to complete bottom and berm top elevations. Details are provided in Section 6.2.2.1.

The significant site grading activities discussed previously and summarized in Table 6-10 involve excavating an estimated 114,000 yd^3 of material and filling 123,000 yd^3. Under the current scenario, cut and fill are nearly balanced. Care in design and planning will be required to ensure sufficient quantity of materials for projected fill needs at the site. Based on this data, sufficient fill may not be available. In this case, additional cost not budgeted in this Closure Plan will be incurred to import borrow fill material from external sources. Final topography construction costs are included in Tables 6-8, 6-9 and 6-11.

Table 6-10
Earthmoving Volumes

Site Location	Cut (yd^3)	Fill (yd^3)
West Pond	50,000	6,000
Southeast Pond	63,895	1,000
South of West Pond	0	24,000
Trench Backfill	0	20,000
Enhanced Cap Fill[1]	0	72,148
Totals	113,895	123,148

[1] Vegetative cover volume only. Low permeability soil is assumed to be available in-place on un-capped trenches. Drain layer sand is assumed to be purchased from off-site sources.

6.2.2.3 Vegetation

The last phase of final site grading will be to place topsoil and plant vegetation, as required. CNS anticipates 10 acres outside of enhanced cap areas will require establishment of grass cover. CNS' estimate of topsoil volume is based on installing approximately three inches of topsoil. Vegetated acreage does not include the floors of the new ponds, which will not be grassed.

Site areas will be seeded with a mix of Bahia, Bermuda and Rye, selected as hardy species that retard erosion and provide substantial transpiration. The seeded areas will be

fertilized to ensure proper root establishment and continued growth. Table 6-11 summarizes costs of topsoiling and seeding for all site areas except enhanced caps. Topsoil and vegetation costs for enhanced caps are budgeted as part of cap construction.

Table 6-11
CNS Grading Costs

Site Final Grading and Contouring	Contractor CNS Labor	$116,908 $2,336
Final Trench Backfill	Contractor CNS Labor	$89,040 $4,532
	Subtotal	$212,816
G&A Allocation		$12,769
	Subtotal	$225,585
Fee		$31,582
Total		$257,167

6.2.2.4 Estimate of Erosion Rates

An estimate of long-term erosion rates at the Barnwell site is provided below. This calculation is provided to demonstrate that CNS caps are of sufficient thickness to provide long-term waste cover. Erosion data can also be used to estimate sediment accumulation rates in site water management ponds.

The erosion calculation assumes completed disposal site with established grass cover and little or no bare soil. Given these conditions, CNS has selected the Universal Soil Loss Equation (USLE) to estimate erosion rate (USDA, 1978). The USLE is an empirical model commonly used to determine long-term average soil loss. This calculation does not consider the possibility of gully erosion, which may contribute to loss of cover thickness under certain degraded cover scenarios. For the flat slopes at CNS and grass cover, gully erosion should be rare (Golder, 1991).

The USLE model is represented by the following equation:

A=RKLSCP

Where
A = Soil Loss Rate (tons/acre/yr)
R = Rainfall Factor
K = Soil Erodibility Index
LS = Length Slope Factor
CP = Cover Practice Factor

Variables in the USLE equation are described below. The Rainfall Factor (R) represents the erosive effect of falling rainfall at the Barnwell site and is based on rainfall patterns for different regions of the country. An average annual value of 275 has been selected for the Barnwell site region (USDA, 1978). The soil erodibility factor (K) represents a soil's susceptibility to erosion. An average value of 0.20 was selected based on Soil Conservation Service (SCS) values for the soil series found at or near the Barnwell site and lab test data from local topsoils. The Length Slope factor (LS) incorporates the effect of slope and slope length on erosion. CNS assumes two different LS factors because surface grades for enhanced cap areas (~3% slopes) are typically steeper than other site areas (~0.5 to 1%). The LS values determined for enhanced cap areas and all other areas are 0.35 and 0.26, respectively. The combined Cover Practice (CP) factor represents cover quality (vegetation type and amount) and whether soil conservation practices are applied. CNS has selected a value of .003 to represent long-term cover conditions at the Barnwell site. This value assumes an established grass cover over 95 to 100% of the site. Using the values listed above, the Barnwell site's erosion rate (A) ranges from .04 to .06 tons/acre/year depending on surface slope.

At .06 tons/acre/year the average decrease in land surface each 100 years is 0.03 inches. At this rate, the six inches of topsoil covering all trenches will last longer than 500 years, ensuring long-term protection of the critical components in the enhanced cap.

6.2.3 Permanent Trench Identification

Permanent identification of completed trenches requires brass markers stamped with the trench number and placed in reinforced concrete at each trench corner and a granite information marker placed within the boundaries of the trench near one end.

Permanent brass corner markers are installed after enhanced cap construction at locations established by the Barnwell site registered land surveyor. Until 1984, CNS used granite for trench corner markers. Since that time, CNS has used a reinforced concrete and brass marker design. Most original granite corner markers have been replaced with the new design as a result of enhanced cap construction on older trenches.

The granite information markers (headstones) will be approximately 30" x 16" x 4" thick. As with corner markers, each information marker will be embedded into the ground. The following information will be etched or sandblasted into the stone:

LOW-LEVEL RADIOACTIVE WASTE
Trench number
Trench Length in Feet
Trench Width in Feet
Total Activity in Curies
Total Amount of Source Material in Pounds
Total Amount of Special Nuclear Material in Grams
Volume of Waste in Cubic Feet
Completion Date of Trench Operations

During the Phase I closure period, CNS has budgeted to re-survey all trench corner locations and to re-establish site bench marks. This activity will serve to verify trench location records and field monuments. The costs for re-survey and information marker installation are provided in Table 6-12.

Table 6-12
Permanent Marker Installation

Marker Installation	CNS Labor	$14,589
	CNS Equipment	$6,840
	Trench information markers (130 @ $550 each)	$71,500
	Contractor	$26,260
	Subtotal	$119,189
G & A Allocation		$7,151
	Subtotal	$126,340
Fee		$17,688
Total		$144,028

6.2.4 Site Maintenance

CNS will continue the trench inspection and maintenance programs described in Section 3.2.3 during the closure period. Maintenance activities include grass cutting, fertilization and seeding to maintain grass cover on completed trench areas. Erosion and other repairs (such as minor subsidence and surface water drainage repairs) will be made as required. CNS will continue to maintain roads for site inspections and control as well as for access to site monitoring points. These costs are included in the routine maintenance section of Table 6-13.

CNS assumes one significant subsidence repair every two years. Subsidences are considered significant if they impact the geomembrane liner of the cap. To repair a significant subsidence

on a completed enhanced cap, CNS will use its earthmoving personnel to uncover subsided areas and a contractor to repair affected geomembrane and geosynthetic clay liner. Cost to make this kind of repair is also included in Table 6-13.

Table 6-13		
Site Maintenance Costs During Closure (15 Months Cost)		
Routine Maintenance	CNS Labor CNS Equipment Contractor	$36,993 $346,409 $16,858
Grass Cutting	CNS Labor CNS Equipment	$11,298 $46,063
Enhanced Cap Subsidence Repair	CNS Labor CNS Equipment Contractor	$6,776 $2,746 $4,250
	Subtotal	$471,391
G & A Allocation		$28,283
	Subtotal	$499,674
Fee		$69,954
	Subtotal	$569,629
Building and Equipment Maintenance Cost During Closure (15 Months Cost)		
	CNS Labor Equipment/Supplies	$76,518 $7,500
	Subtotal	$84,018
G & A Allocation		$5,041
	Subtotal	$89,059
Fee		$12,468
	Subtotal	$101,527
Total		$671,156

6.3 Records Storage Facility

CNS proposes to establish a facility at the Barnwell site for storage of site records (working copies of microfilm records). The facility will consist of an office area comprised of general office equipment and storage cabinets for microfilm storage. This facility will be located on state owned property. Environmental and characterization samples may be stored in the office area or another appropriate existing location.

6.4 Survey Control

CNS uses a site grid system to accurately locate trenches, monitoring wells and other site features. This system is tied to South Carolina Geodetic Survey benchmarks and to Savannah River Site monuments (identified as SRO), with SRO monument 128 serving as the origin location for the disposal site. The north direction for the site grid system parallels the current west disposal area boundary.

Precise surveys documenting trench and monitoring well locations and elevations are needed to ensure compliance with license and other requirements. Surveys are required to ensure appropriate separation between adjacent disposal trenches and separation of trench bottoms from the water table.

CNS maintains five permanent benchmarks on the disposal site to facilitate survey work. Trench, monitoring well and other critical surveys at the Barnwell site are performed by a registered land surveyor.

6.5 Site Monitoring

During the closure period, monitoring will continue with the same media, sampling frequencies and analyses as the current programs (Section 3.4). CNS anticipates fewer monitoring points will be required. The closure period monitoring program is summarized below. Sampling costs include both radiological and non-radiological sampling.

Sumps will be checked quarterly for evidence of water intrusion into the trenches. Samples will be taken for gamma-emitting radionuclides and tritium analysis only when standing water is detected. No sumps are monitored as part of the non-radiological environmental monitoring program.

During closure, the non-radiological groundwater monitoring program will be continued. The non-radiological data are documented in quarterly non-radiological monitoring reports submitted to DHEC.

Sixteen points for surface soil and vegetation sampling will be defined for the closure monitoring program. Each sample point will be sampled

quarterly for both media. The water, soil and vegetation samples described above will be analyzed for gamma-emitting radionuclides and tritium.

Air sampling using a particulate filter arrangement will continue in support of closure activities at the twelve site environmental stations. Every two weeks filters will be changed and filter media will be analyzed. Environmental thermoluminescent dosimeters (TLDs) will be maintained and exchanged quarterly. The existing program will continue through closure and may be adjusted for in-region-only operations.

Table 6-14 details the radiological and non-radiological monitoring programs planned for the closure period.

Table 6-14
Closure Period Monitoring Program

Sample Description	# Locations	Type	Collection Media	Frequency	Analysis
Wells[1,2]	120	Grab	Water	Quarterly	Gross alpha/beta, Gamma Isotopic, and Tritium
	28	Grab	Water	Quarterly	pH, Conductivity, Total Organic Carbon, Volatile Organics
	28	Grab	Water	Annually	Carbon-14
	16	Grab	Water	Annually	Acids, Base/Neutrals, Pesticides/PCB's, Phenols, Cyanide, Metals
Surface Water [3]	8	Grab	Water	Quarterly	Gross alpha/beta, Gamma Isotopic, and Tritium
	2	Grab	Water	Annually	Carbon-14
	2	Grab	Water	Quarterly	VOC, TOC
	2	Grab	Water	Annually	Acids, Base/Neutrals, Pesticides/PCBs, Phenols, Cyanide, Metals
Observation Sumps[2,4]	151	Grab	Water	Quarterly	Gamma Isotopic and Tritium
Surface Soil	16	Grab	Soil	Quarterly	Gamma Isotopic and Tritium
Sediment [3]	4	Grab	Sediment	Annually	Gamma Isotopic and Tritium
Samples of Opportunity[5]	500	Grab	Various	Various	Gross alpha/beta, Gamma Isotopic, and Tritium as needed.
Vegetation	16	Grab	Vegetation	Quarterly	Gamma Isotopic and Tritium
External Gamma	105	Continuous	TLD	Quarterly	Exposure
Atmospheric	12	Continuous	Particulate Filter	Every 2 Weeks	Gross Alpha/Beta, Gamma Isotopic,

(1) Includes selected wells from the existing monitoring programs.
(2) Water levels measured quarterly.
(3) Same locations as the current monitoring program.
(4) All sumps monitored for water accumulation with samples collected when available. As of 6/27/2005, there are 151 sumps in the monitoring program.
(5) Samples deemed desirable. The number of locations represents the total number of samples collected annually.

Table 6-15 summarizes closure-period monitoring program costs. The table includes all labor and supplies for sampling and sample analysis.

Table 6-15
Site Monitoring Costs During Closure (15 Months)

Sample Collection and Analysis	CNS Labor CNS Equipment Contractor	$391,629 $172,125 $67,815
Stormwater	CNS Labor Contractor	$4,786 $17,500
Routine Well Maintenance	CNS Labor	$15,038
Environmental Program Waste Disposal	CNS Labor Contractor	$1,216 $77,750
	Subtotal	$747,859
G & A Allocation		$44,872
	Subtotal	$792,730
Fee		$110,982
Total		$903,713

The closure monitoring costs assume DHEC acceptance of the closure groundwater monitoring program, which will be submitted prior to closure. To achieve the proposed closure monitoring well configuration, up to 133 monitoring wells will need to be abandoned and sealed. The estimated costs of these abandonment activities are listed in Table 6-16.

Table 6-16
Monitoring Well Abandonment Costs

Monitoring Well Abandonment	CNS Labor	$83,788
	Materials	$19,232
	Contractor	$140,140
	Subtotal	$243,160
G & A Allocation		$14,590
	Subtotal	$257,750
Fee		$36,085
Total		$293,835

6.5.1 Costs of Managing Environmental Program Wastes

As a result of the environmental monitoring program, radioactive waste will be generated that will require processing and disposal. The radioactive waste will be in two forms: water from the

groundwater monitoring program and dry active waste from sample collection and analysis activities.

The guidelines for management of the water are summarized as follows:

- Purge water removed from environmental wells during sample collection having a concentration less than or equal to 50% of the National Primary Drinking Water Standard Maximum Contaminant Level (MCL) for tritium, will be discarded at the monitoring well location.

- The maximum volume to be discarded per well shall not exceed 50 gallons. Volume in excess of 50 gallons will be placed into a water management basin (such as the West Pond).

- Purge water having a tritium concentration greater than 50% of the MCL will be treated for disposal.

- Water collected for analysis will also be managed by these criteria. Upon completion of the analyses, if the only nuclide present is tritium, and its concentration is less than or equal to 50% of the MCL, the sample water will be discarded in an approved water management pond. If other nuclides are present or the tritium concentration is greater than 50% of the MCL, the water sample will be treated. Currently CNS treats such water at the Duratek Bear Creek Facility. Cost estimates provided assume Bear Creek treatment.

- Water acquired during the construction and/or re-development of environmental monitoring wells will be analyzed on a case-by-case basis to determine tritium concentration. If the concentration is less than or equal to 50% of the MCL, the water will be placed into an approved water management pond. If the concentration is greater than 50% of the MCL, it will be treated.

& All water collected from trench monitor pipes and sumps will be treated.

The annual volume of water produced by the environmental sampling program that would require treatment based on currently approved guidelines is approximately 6,930 gallons. Also, solid radioactive waste consisting of sampling supplies, protective clothing and sample residuals will be about three 55-gallon drums of dry active waste annually. The cost for managing this waste is provided in Table 6-15.

6.6 Performance Objectives Assessment

Before the end of the closure period, CNS will submit a comprehensive report evaluating compliance with site performance objectives. Each performance objective described in Section 9.0 will be evaluated. All objectives except Objective E have been addressed elsewhere in the closure plan. Demonstrating compliance with Objective E will require a site radiological performance assessment. The steps in this analysis are described below.

At the time of site closure, CNS will evaluate environmental data. The average environmental data will be used to estimate peak radiation dose rates to any member of the public at compliance locations. This evaluation will be conducted consistent with recent site radiological performance evaluations (CNS, 2003).

The most current average water level map and stream flow data will be used to calibrate the groundwater model. CNS will calculate groundwater pathlines and compare them to known locations of tritium, calibrating the model so calculated pathlines match tritium locations indicated by CNS environmental monitoring data.

Peak dose rates at a compliance point along Mary's Branch creek will be determined by:

- Evaluating radionuclide mobility by distribution coefficient data and by direct environmental monitoring data.

- Plotting stream tubes from wells showing elevated radionuclide concentration.
- Assigning the highest average radionuclide concentration obtained from sample points to the stream tube. Stream tubes intersecting several monitoring wells will be assigned the highest average concentration of all monitoring wells.
- Assigning flow rates to water entering Mary's Branch according to the results of the groundwater flow model and radionuclide concentration determined by the above method.
- Using a mixing cell stream transport model to calculate maximum concentration of radionuclides at the compliance point.

The peak dose rate calculation incorporates environmental monitoring data and accounts for the mobility and potential impact of radionuclides not observed in environmental data. It also estimates dose rates from potentially important radionuclides that may contribute to dose rates at compliance locations.

Finally, CNS will calculate peak hypothetical dose rates to a continuous consumer of water using dose conversion factors from DHEC Regulation 61-63, Part II, Appendix B, Table 2. Current peak dose rate calculations indicate continued compliance into the future.

CNS has not planned air pathway dose assessments, because airborne dose rates appear to be negligible based on current environmental monitoring measurements. CNS also assumes additional monitoring wells and/or characterization boreholes will not be required to complete final performance assessment studies.

Additional data collected since the ERPV will help reduce the uncertainty in the new ERPV results. With the incorporation of additional environmental measurements, trends about the disposal site performance will be measured. Therefore, CNS has not planned a strict stochastic analysis of site performance. Where warranted, the new ERPV will include discussions of uncertainty and conservatism.

CNS has included costs to perform a chemical risk assessment should one be required by DHEC to facilitate Barnwell site closure. This assessment will use elements of the site radiological performance assessment. The method of risk assessment assumes the use of guidance from the U.S. EPA Risk Assessment Guidance for Superfund (RAGS) (EPA, 1989), and input from DHEC. The methodology being costed is as follows.

The concentrations of various chemicals observed in groundwater samples will be estimated at a compliance location. Public health risk assessment is calculated at the compliance location by assuming hypothetical human population exposure to these chemicals, and the results are compared to acceptable levels of exposure. These calculations are conducted according to RAGS. Likewise, an ecological exposure assessment may be conducted using the same chemical data, with calculations also conducted according to RAGS.

Table 6-17 summarizes anticipated cost associated with evaluation of performance objectives and risk assessment. The cost estimate includes an additional $1,000,000, requested by DHEC, intended as a reserve for DHEC to hire contractors and peer review associated with site closure and performance assessment evaluations. DHEC assessment reserve funds may be expended during Phase I closure and into the post-closure observation period.

Table 6-17
Performance Objectives Verification

• Prepare Performance Objectives Verification Plan • Update Environmental Database • Update and Calibrate Site-Specific Groundwater Flow Model and Rerun Pathway Calculation • Update ERPV • Document Results • Nonradiological Risk Assessment • Prepare Performance Objectives Verification Rpt(s)	CNS Labor Contractor	$227,765 $320,698
	Subtotal	$548,463
G & A Allocation		$32,908
	Subtotal	$581,371
Fee		$81,392
	Subtotal	$662,763
DHEC Assessment Reserve		$1,000,000
Total		$1,662,763

6.7 Property Boundary

CNS currently leases a 235-acre area from the state of South Carolina for use as a disposal site. At closure, CNS will recommend that property boundaries and designations be changed to reflect the best configuration for long-term maintenance and monitoring of the disposal facility. To achieve these goals, CNS believes the size of state property will need to increase to approximately 300 acres to incorporate certain existing CNS property within the current restricted area and closure stormwater management features outside the current restricted area boundary. Proposed property boundary is shown on Figure 6-2. CNS property transferred to the State will be sold at market rates. This cost is included in Table 6-18 below.

CNS property south of the proposed state property boundary extends to the headwaters of Mary's Branch of Lower Three Runs Creek, encompassing the groundwater pathway from disposal site trenches on state property to ground water discharge at the creek. CNS has placed a deed restriction on this property, limiting the kinds of development allowed on the property.

Adjustments to state property will require installation of new fenceline. Any new fenceline will be specified consistent with current restricted area fence standards. For estimation, CNS assumes replacing all existing site fenceline and adding new fenceline along adjusted boundaries. Fence costs are included in Table 6-18 below. General site security and fence inspection costs are addressed in Section 6.1.5.

Table 6-18
Fence and Property Boundary Relocation

Land Purchase		$130,000
Land Survey	Contractor	$10,000
Fence Relocation	Contract Labor + Materials	$160,000
	Subtotal	$300,000
G & A Allocation		$18,000
	Subtotal	$380,000
Fee		$44,520
Total		$362,520

6.8 Project Management and Other Closure Costs

Prior to the start of the Phase I closure period, CNS will assign a closure project management team to manage decommissioning work. This team will consist of project management oversight as well as technical and direct corporate support not included in the direct costs of implementing closure tasks. Additionally, this team will be supported by indirect CNS corporate functions and will require certain infrastructure and equipment. Project management personnel as well as support costs are budgeted as part of closure. CNS has also budgeted in the Closure Plan for utilities, taxes, insurance and fees that are expected to be incurred during Phase I closure. Project management and associated costs are described in the following sections.

6.8.1 Project Management Team

The proposed functional organization chart for the Phase I closure project is shown in Figure 6-3. This team will manage closure tasks, provide technical support and interface with DHEC. CNS has scheduled tasks to level workload for the 15 months required to complete closure (see Section 6.10). Management team labor costs are provided in Table 6-19. Personnel costs, other than project management team costs, are included in specific task budgets.

The project management team labor in Table 6-19 also includes operational technical support costs such as safety, quality assurance, financial controls (e.g., billing, accounts payable, purchasing), human resources and information systems. CNS also plans to provide, for CNS employees directly involved in closure, compensation incentives to help retain quality, experienced CNS personnel to the end of Phase I closure.

Table 6-19 Project Management (Total for 15 Months of Closure)		
Project Management Team	CNS Labor	$1,918,071
	Equipment	$26,290
Employee Incentive		$457,233
	Subtotal	$2,401,594
G & A Allocation		$144,096
	Subtotal	$2,545,690
Fee		$356,397
Total		$2,902,086

6.8.2 Utilities, Taxes and Fees

The disposal site and associated infrastructure incur costs for utilities, taxes and insurance. For Phase I closure, CNS assumes these costs will remain consistent with current expenditures. CNS also anticipates that DHEC's current disposal site licensing fee will continue through the closure period. These ancillary costs are provided in Table 6-20. The estimate does not cover surcharges for administrative costs of the South Carolina Public Service Commission, Atlantic Compact Commission and Budget and Control Board, which are now funded through surcharges on waste receipts.

Table 6-20 Other Facility Costs (15 Months)	
Utilities	$268,534
General Supplies and Materials	$125,000
Subtotal	$393,534
G & A Allocation	$23,612
Subtotal	$417,146
Fee	$58,400
Taxes	$134,496
Insurance	$1,176,510
DHEC Fees / Other Fees	$349,439
Total	$2,135,991

6.9 Completed and On-going Closure Activities

Since 1991, CNS has implemented closure activities paid for from the decommissioning trust fund. The activities funded in this manner were primarily enhanced capping along with closure water management feature construction and site performance assessment. Completed or on-going decommissioning activities are described below.

Since 1991, CNS has constructed six phases (approximately 96 acres) of enhanced trench cap. Each enhanced cap has been constructed to a DHEC-approved final design grade and contour to ensure long-term stability and to meet site performance objectives. Further details are provided in Section 6.2.1. This work has been funded from the decommissioning trust fund with South Carolina Budget & Control Board authorization.

In 2002, CNS completed a performance assessment study of the Barnwell disposal facility termed the Environmental Radiological Performance Verification. The evaluation involved state-of-the-art environmental sampling, laboratory analysis and performance assessment modeling to demonstrate current and projected compliance with environmental performance objectives of the disposal site license. The work received independent technical review and concurrence from DHEC. Much of this work was funded as a decommissioning activity.

In 2004 and 2005, CNS completed most of the construction required for the west closure pond project. This project involved re-locating and expanding water management capabilities for the western watershed of the Barnwell Site. This decommissioning project is described further in Section 6.2.2.

CNS anticipates a Phase 7 capping project during 2007 to cover the area shown on CNS drawing B-500-D-300. Cap construction schedule and costs are provided in Table 6-8. With DHEC concurrence, projects scheduled during the Phase I closure period may be implemented at an earlier date alongside current disposal operations. Such scheduling could shorten the length of the closure period, reduce costs and allow CNS to

gain valuable experience and preparation for performing final closure activities.

6.10 Closure Cost and Schedule

This section describes the schedules and budgets for decommissioning activities planned for the next three years of site operations and during the Phase I closure period. The costs for in-region (Phase II) closure and the post-closure observation periods are provided in Sections 6.11 and 8.7, respectively.

In accordance with the Atlantic Compact Act, CNS anticipates that Phase I closure will begin July 1, 2008, concurrent with the start of in-region disposal operations. However, for cost estimating purposes only, it is assumed that waste receipts will cease as of July 1, 2008, and the decommissioning trust fund must pay for direct closure tasks as well as the full cost of on-going site support such as routine environmental monitoring, maintenance, security, taxes and insurance. CNS anticipates that a significant portion of site closure work can be performed concurrent with in-region-only operations because (1) in-region disposal volumes are anticipated to be small, and (2) in-region operations are proposed to be segregated from other site areas undergoing closure.

All cost estimates are provided in 2005 dollars (unless otherwise noted). Further details on closure costs and schedules are provided in the following sections.

6.10.1 Closure Manpower

For each individual closure task shown on the summary level work breakdown structure in Figure 6-3, CNS has estimated manpower and other resource requirements to complete work in an efficient and quality manner. These estimates and associated costs are provided in the respective Closure Plan sections. CNS has evaluated these manpower and resource needs and developed an overall schedule making efficient use of qualified personnel and available equipment.

Phase I closure period activities have been scheduled to allow the designated closure project team to complete this work in an orderly and efficient manner. This team will be comprised of individuals with the necessary skills to perform all tasks anticipated to remain at closure. Team members will be qualified and cross-trained to support multiple functions.

6.10.2 Closure Schedule

Figure 6-4 shows the detailed schedule of closure activities through Phase I closure. This schedule shows (1) the next three years of closure tasks, which are to be completed alongside normal operational activities, and (2) Phase I closure period tasks, which will require approximately 15 months to complete. CNS plans to start the Phase I closure period on July 1, 2008, at the beginning of in-region-only operations.

FIGURE 6-1

SITE TOPOGRAPHY AND WATER MANAGEMENT

(THIS FIGURE AVAILABLE IN HARD COPY)

FIGURE 6-2

PROPOSED FINAL STATE PROPERTY BOUNDARY
(THIS FIGURE AVAILABLE IN HARD COPY)

FIGURE 6-3

CNS Closure Project Work Breakdown Structure

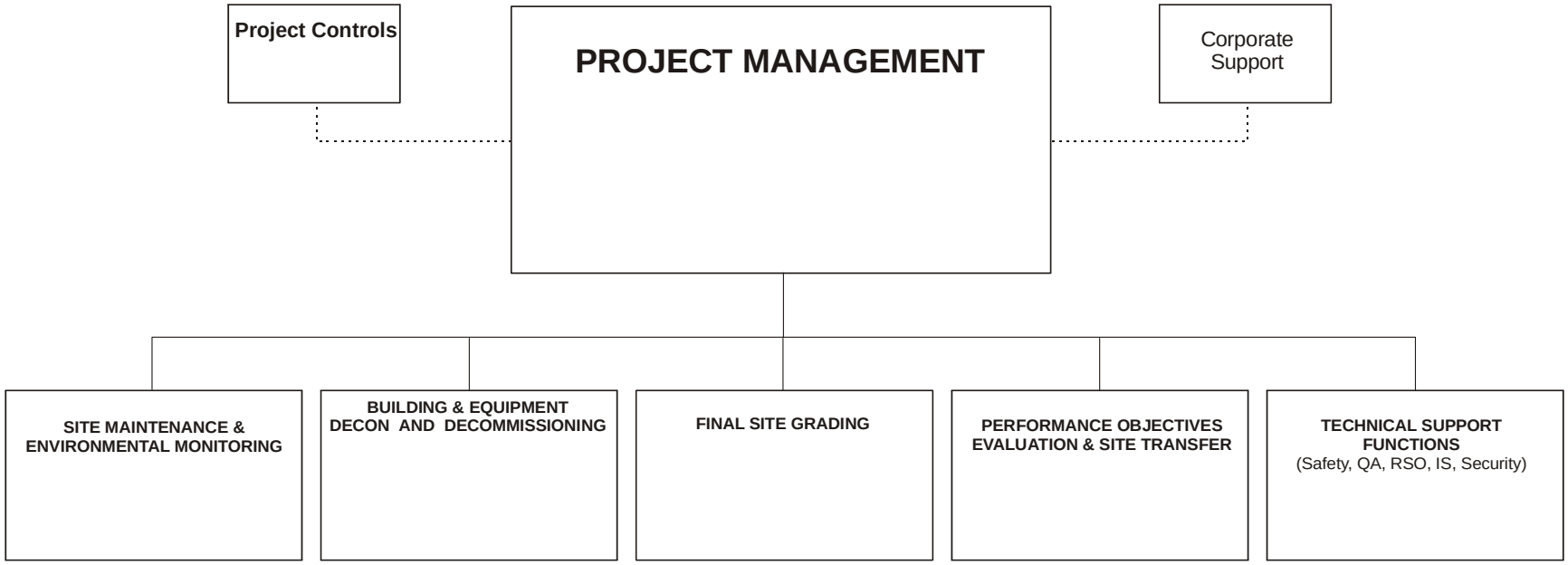


FIGURE 6-4
CLOSURE ACTIVITIES SCHEDULE

(THIS FIGURE AVAILABLE IN HARD COPY)

6.10.3 Closure Cost Summary

Within the context of the Closure Plan, CNS has estimated costs for the individual tasks required for closure, as well as for on-going routine activities such as environmental monitoring, site maintenance, security and administrative functions. A summary of closure activity costs has been consolidated from the tables throughout Section 6.0 and is provided in Table 6-22. This table also tracks the balance of the decommissioning trust fund to ensure sufficient funds to implement closure tasks.

CNS assumes for the purpose of scheduling that after the next three years (2005-2008), the site goes into closure, concurrent with the start of in-region only operations. At this time, all remaining closure activities are performed except in the areas and facilities required for in-region-only operations.

For cost estimating purposes only, CNS assumes no disposal operations concurrent with decommissioning activities. This assumption increases closure costs significantly because the costs of certain routine tasks (e.g. security, site maintenance and monitoring, etc.) must be borne entirely by the decommissioning fund. To complete all identified closure activities, CNS has estimated that the Phase I closure period will last approximately 15 months.

The decommissioning costs provided in Table 6-22 are generally task-specific, except for (1) the project management item which covers project management, general technical support and direct administrative functions (e.g. finance, purchasing, etc.) and (2) utilities, taxes and fees.

G&A fees applied to each cost table cover indirect payroll, benefits and general company administration. Some of the activity cost tables include direct equipment costs. In most cases, CNS assumes use of leased equipment.

6.11 In-Region Operations (Phase II) Closure Period

CNS assumes 30 years of in-region-only disposal operations. In-region-only operations will require the use for disposal of about 3-4 acres of the site, based on 240,000 ft^3 received over 30 years. Final Phase II closure will entail the following activities.

Table 6-21
In-Region (Phase II) Closure Period Activities

Project Management & Records Transfer	$534,000
Enhanced Capping	$575,000
Facilities & Equipment Decontamination	$40,000
Final Site Survey	$120,000
Final Performance Objectives Verification	$600,000
Subtotal	$1,869,000
G & A	$112,140
Subtotal	$1,981,140
Fee	$277,360
Total	$2,258,500

The in-region closure period is assumed to last about one year primarily based on the potential duration of performance assessment activities. Costs for these final closure activities are estimated at approximately $2.3 million (2005 dollars). CNS assumes this cost will be reserved in the decommissioning trust fund to cover Phase II closure. To demonstrate adequacy of the current decommissioning fund, Table 6-22 includes the costs of Phase II closure. CNS has accounted for the costs of routine site maintenance, monitoring and security during the Phase II Closure Period as part of long-term care funding at the routine annual costs estimated in Table 8-11.

Enhanced caps to be installed for in-region operations trenches are assumed to be of the same design as current caps. These caps may be installed as trench areas are completed or during the Phase II closure period. The only facility remaining to be surveyed and decontaminated will be the Cask Maintenance Building. Equipment decontamination and disposition costs are also included. A final site survey will be performed,

which will encompass both the in-region operations area and previous closed parts of the disposal site.

After 30 years of additional operations and observation of closed site areas, CNS expects most site performance issues will be resolved. However, CNS includes the cost of performance assessment and performance objectives verification consistent with Phase I closure estimates to provide further documentation of site conditions and performance.

6.12 Financial Assurance

On March 24, 1981, CNS entered into a Trust Agreement with the State of South Carolina to provide monies to establish a site decommissioning fund. This fund is to be used to complete the requirements of the Site Closure Plan. In 1981, at the time CNS entered into the Trust Agreement, CNS contributed a lump sum of approximately $1.7 million to the fund. No additional contributions were made until April 1, 1993, when a surcharge of $4.11 per cubic foot was applied to incoming waste volume for addition to the fund. This contribution lasted for three months. Contributions were reinstated effective January 1, 1994, at $12.60 per cubic foot to cover costs of enhanced capping at the Barnwell site. On July 1, 1995, the contribution was reduced to the current $4.20 per cubic foot.

Table 6-22 provides the financial schedule for decommissioning costs in 2005 dollars. Interest accrues to the fund and is added to the fund balance periodically. CNS has assumed a real increase in fund value of 3% annually based on recent fund performance history. Based on the current amount in the decommissioning trust fund and the proposed additions to the fund from expected waste receipts and interest, sufficient monies are available to complete the activities discussed in this Closure Plan for Phase I and Phase II closure.

Based on the estimated costs to perform the remaining closure activities, the closure fund contains sufficient funds to complete site decommissioning. The remaining balance in the decommissioning trust fund will be reserved first for Phase II closure and then used to pay for post-closure observation maintenance and monitoring costs until the fund is depleted.

TABLE 6-22 CHEM-NUCLEAR SYSTEMS, LLC DECOMMISSIONING TRUST FUND PROJECTION (2005 UPDATE)

TASK IDENTIFICATION	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	TOTAL
Closure Activities (FY 2005-2007)						
Phase 7 Enhanced Cap			$691,582			$691,582
Closure Period Activities (FY 2008/2009)						
Project Management				$2,321,664	$580,422	$2,902,086
Facility Decommissioning				$1,161,775		$1,161,775
West Pond Completion				$87,601		$87,601
Southeast Water Management				$324,939		$324,939
Well Abandonment				$293,835		$293,835
Phase 8 Enhanced Cap				$1,118,334		$1,118,334
Phase 9 Enhanced Cap				$2,452,287		$2,452,287
Final Site Grading & Trench Backfill				$257,167		$257,167
Permanent Trench Markers				$144,028		$144,028
Performance Objectives Verification				$530,208	$132,555	$662,763
Final Property Boundary				$362,520		$362,520
Final Site Survey				$70,977	$70,977	$141,954
Records Transfer				$99,900	$24,967	$124,867
DHEC Assessment Reserve				$800,000	$200,000	$1,000,000
On-going Maint/Monitoring Support (FY2008/2009)						
Site Monitoring Programs				$722,970	$180,743	$903,713
Site Maintenance				$455,700	$113,929	$569,629
Building / Equipment Maintenance				$81,221	$20,306	$101,527
Security				$353,295	$88,324	$441,619
Other Facility Costs				$1,708,800	$427,191	$2,135,991
Closure Activities After In-Region Period (Phase II)						$2,258,500
Beginning Fund Balance[1]	$19,222,193	$19,972,074	$20,737,949	$20,798,559	$7,885,126	$19,222,193
Fund Expense			$691,582	$13,347,221	$1,839,414	$18,136,717
Added to Fund	$162,960	$156,240	$134,400			$453,600
Interest Earned[2]	$586,921	$609,635	$617,792	$433,788	$193,233	$2,441,369
Ending Fund Balance	$19,972,074	$20,737,949	$20,798,559	$7,885,126	$6,238,945	$3,980,445

[1] *Projected balance as of July 1, 2005.*
[2] *Assumed 3% APR.*

7.0 SITE TRANSFER TO CUSTODIAL AGENCY

This section describes the actions required to transfer the disposal site and its required relevant records to the State's custodial agency.

7.1 Transfer of Control & Responsibility

At the end of Phase I closure and post-closure observation, CNS will request DHEC concurrence that the site, except those areas designated for in-region operations, has been closed in a manner meeting performance objectives. This Closure Plan describes the activities that must be completed to effect Phase I closure and transition to in-region operations. Table 7-1 provides a schedule for anticipated Phase I closure submittals. At the end of in-region operations when disposal operations at the Barnwell site cease, CNS will perform Phase II closure and post-closure observation, then transfer possession and control of the site to the custodial agency of the State of South Carolina.

Upon completion of Phase I decommissioning activities, remaining available monies in the decommissioning trust fund will be used to perform post-closure observation period maintenance and monitoring until expended. Thereafter, site monitoring and maintenance, except for areas directly supporting in-region operations, will be paid from the long-term care fund.

During the past few years, CNS has performed specific projects for site closure such as installing enhanced caps. DHEC approvals were obtained before these activities began and reimbursement has been received from the decommissioning trust fund after completion. CNS expects to continue this practice for remaining closure activities. This approach provides for effective use of CNS and DHEC technical personnel and allows sufficient review time for critical aspects of site closure. Table 7-1 lists the approvals that CNS has identified as necessary to proceed with Phase I closure activities during operations over the next three years.

CNS will prepare and submit a final Closure Plan one year prior to closure. As with previous Closure Plans, this Closure Plan will document the closure activities completed to date and outline the remaining activities required for site decommissioning and closure. The Phase I closure period will take about 15 months. At the end of closure activities, CNS will submit a notification of completion of closure activities, as well as a performance objectives verification report(s). At this point, the post-closure observation period will begin, during which CNS will continue to monitor and maintain the site. During post-closure observation, DHEC will perform an evaluation to determine that the requirements for closure have been met. Upon the satisfaction of DHEC, CNS will submit a final report of performance objectives verification.

Table 7-1
DHEC Phase I Closure Approvals

Request for Approval	Estimated Submittal Date	Successor Tasks	Successor Task Start Date
Enhanced Cap Phase 7 Design Report	May, 2006	Phase 7 Enhanced Cap Construction	September 2007
Enhanced Cap Phase 8 Design Report	May 2006	Phase 8 Enhanced Cap Construction	July 2008
Enhanced Cap Phase 9 Design Report	May 2006	Phase 9 Enhanced Cap Construction	July 2008
Southeast Pond Design Report	January 2007	Construct Southeast Basin	July 2008
Phase I Final Closure Plan	June 2007	Phase I Closure Activities	July 2008
Performance Objectives Verification Plan	June 2007	Start of Decommissioning Period	July 2008
Site Transfer Plan	June 2007	Fence Relocation	July 2008
Closure Groundwater Monitoring Plan	January 2008	Well Installation/Abandonment	July 2008
Building and Equipment D & D Plan	January 2008	Start of Decommissioning Period	July 2008
Site Radiological Survey Plan	January 2008	Start of Decommissioning Period	July 2008
Closure Activities Completion Notification	September 2009	Post-Closure Observation Period	October 2009
Performance Objectives Verification Report(s)	September 2009	DHEC Review and Approval	

7.2 Transfer Records

As part of Phase I closure, CNS will identify, transfer and provide storage for certain Barnwell site records for custodial use by the State of South Carolina. Section 7.2.1 describes records routinely transmitted to DHEC as part of routine site operations. In Section 7.2.2 of this plan, CNS has

proposed a comprehensive list of records meeting license criteria for transfer. These records are primarily waste disposal, trench construction and maintenance, environmental monitoring and customer specific waste evaluation/approval records. Section 6.3 describes the proposed on-site facility for storing working copies of these records. Permanent copy storage is addressed in Section 7.2.3.

7.2.1 Records Routinely Transmitted to DHEC

Through normal operations and in accordance with license requirements, CNS routinely transmits certain records to DHEC, including Site Receipt and Burial Activity Reports and Environmental and Site Monitoring Reports. CNS will continue transmitting records of on-going monitoring activities during the closure period as well as waste reports generated as part of in-region operations. Routine reports are described below.

7.2.1.1 Waste Receipt Reports

The Site Receipt and Burial Activity Report, which is provided to DHEC monthly, consists of a combination of reports relating to the types and quantities of waste received for burial at the disposal site. These reports are generated using data taken directly from the Radioactive Shipment Manifest forms provided with incoming shipments. The following paragraphs describe the individual monthly reports comprising the Site Receipt and Burial Activity Report.

The report **Volume By Waste Description (Report No. 304)** provides a breakdown of waste volumes by category of waste. Total volume is divided into fuel cycle and non-fuel cycle waste volumes, which are then further categorized by individual waste type (resin, solidified liquid, etc.) and physical form (dewatered, solid, etc.). Volume, relative percentage and activity for each category are provided.

The **Disposal By State Report (Report No. 301)** provides the total volume of waste disposed by state. The volumes are also broken out by specific waste generators within each state. Specific generator categories include: utility, government, university, hospital, industry and other.

The **Volume Buried By State For SC DHEC (Report No. 306)** lists the total volume and volume percent of waste buried each month from individual states and volume percent by Compact.

The **Trench Recap (Report No. 204)** provides cumulative totals of waste activity (in millicuries), grams of SNM, source pounds, SNM packages, waste volumes and the opening and closing dates for each trench. Reports are issued for both fiscal and calendar year.

The **Summary of Isotopes Received (Report No. 305)** lists the monthly totals in millicuries of each radionuclide received for disposal.

The total volume of waste generated by each State for each month is displayed in the **Monthly Volume By State (Report No. 302).**

The volume received per month from the state of SC, the Southeast Compact, and other Compacts, and their relative percentages are shown in the **Volume and Escrow by Month Report (Report No. 308).** This report also indicates the remaining volume for the year, the cumulative volume disposed and the escrow account volume.

The **Reactor/Non-Reactor Volume By State Report (Report No. 307)** provides monthly and year-to-date waste disposal volumes for each utility. It also lists the state and compact where the utility is located.

The **Decay Report (Report No. 207)** is a running inventory of the twenty most common and abundant radionuclides received at the Barnwell site. The totals are updated monthly to include new waste activity and take into account radioactive decay. Details of this report are discussed in Section 2.6.

The **Reactor Allocation Report (Report No. 309)** provides waste data for utility-generated waste only. This report lists the utility and facility, state, compact, total volume buried by the facility by month and the cumulative yearly volume.

In addition to the printed reports described above, a computer diskette containing the arrival number, waste generator, receipt date, burial date, trench location code, waste code, waste class, total volume and activity, activity per nuclide, SNM grams and source pounds for each shipment is also provided to DHEC on a monthly basis. This report provides the disposal data for the given month as well as running totals for the year. The information is taken directly from the Radioactive Shipment Manifests provided with each shipment.

7.2.1.2 Waste Shipment Records

All waste shipment records are transferred to microfilm. Shipping records from the beginning of disposal operations have been microfilmed and copies sent to DHEC. These records will serve as a permanent record for materials received at Barnwell. CNS will continue the microfilming program through the site closure period until all the waste shipment documentation is microfilmed and transmitted to DHEC. CNS will discard waste shipment paper records after microfilming.

7.2.1.3 Monitoring Reports

The Site and Environmental Monitoring Reports, which are submitted to DHEC on a quarterly basis, provide the results of sampling and radiological analysis for both on- and off-site monitoring. CNS also prepares a quarterly report documenting results of the Barnwell site non-radiological monitoring program.

7.2.2 Records to be Transferred at Closure

During the Phase I closure period, CNS will generate and transfer records and reports documenting completion of site closure activities and compliance with closure performance objectives. In addition, CNS will transfer the reports, records and drawings required by license for use by the state and/or custodial agency. CNS provides in Table 7-2 a list of proposed records to be transferred. Table 7-2 lists record types, current formats and volumes, and License 097 reference basis. The estimated cost of preparation and transfer of these records is provided in Table 7-3.

The following subsections describe the record classifications identified in Table 7-2.

7.2.2.1 Waste Disposal Records

Waste disposal records are the single largest volume of records generated by CNS that are proposed for transfer. CNS proposes to assemble a complete transfer package of waste disposal records comprised of the following: waste disposal manifests, special waste form approvals and other general correspondence regarding waste disposal. CNS also maintains an electronic database from which routine waste receipt reports are generated. One working copy of this database will be transferred at the end of closure. CNS routinely provides DHEC with these records in the form of microfilm or computer diskettes and will continue to provide these records through waste disposal operations.

TABLE 7-2: BARNWELL SITE CLOSURE TRANSFER RECORDS (2 PAGES)

TABLE 7-2

Barnwell Site Closure Transfer Records (as of June 2005)

	RECORD CLASSIFICATION	RECORD TYPE	CURRENT LOCATION & FORMAT	LICENSE CONDITION AFFECTED	PROJECTED VOLUME/QUANTITY OF RECORDS
1	Waste Disposal Records	Waste Disposal Manifest	Barnwell Receiving Warehouse, Site Administration Storage Areas (Paper), Commercial Storage Columbia (Microfilm) Barnwell vault (Microfilm) Microfilming of these records is an ongoing process. Microfilm Reference: DHEC approval letter for microfilm as the permanent record dated 2/21/86. Microfilm provided to DHEC on a routine basis.	Condition 18 and 98(j)	10 ft^3 (microfilm)
2	Waste Disposal Records	Computerized File and Paper Reports provided to DHEC on a monthly basis.	PNP Department Paper copies of DHEC reports retained.	Condition 20	1 Electronic copy
3	Waste Disposal Records	Reports of Receipt and Disposal of SNM	PNP Department	Condition 79	1 Electronic copy
4	Waste Disposal Records	General DHEC correspondence/Special waste form approvals	Licensing office Paper	Condition 18	50 ft^3 (paper)
5	Waste Disposal Records	Trench Inventory	PNP Department Computer database files	Conditions 18, 79, and 98(j)	1 Electronic copy
6	Trench Construction/ Maintenance Records	Trench Construction Checklists/Trench Inspections Data Sheets/Site Inspection Forms	Construction Coordinator office and Barnwell vault Paper	Condition 98(j)	23 ft^3 (paper)
7	Trench Construction/ Maintenance Records	Trench Qualification Reports	Construction Coordinator office and Barnwell vault Paper	Condition 67	Volume included in #6
8	Trench Construction/ Maintenance Records	DHEC Communications (trench-specific approval letters, etc.)	Construction Coordinator office and Barnwell vault Paper	Condition 68	Volume included in #6
9	Trench Construction/ Maintenance Records	Proposed and as-built drawings (most recent rev.)	Construction Coordinator office (paper) and Barnwell Vault (Mylar) Trench Data from Life Cycle Engineering Report will be used for Trenches 1-45 Paper and/or Mylar	Condition 98(j)	45 ft^3 (paper/mylar)

TABLE 7-2 (Continued)
Barnwell Site Closure Transfer Records (as of June 2005)

	RECORD CLASSIFICATION	RECORD TYPE	CURRENT LOCATION & FORMAT	LICENSE CONDITION AFFECTED	PROJECTED VOLUME/QUANTITY OF RECORDS
10	Trench Construction/ Maintenance Records	As-built enhanced cap	Environmental Lab and Barnwell vault Paper	Condition 98(j)	21 ft^3 (paper)
11	Monitoring Program Records	Quarterly Water Level Reports	Lab Computerized File and Barnwell vault Electronic copies routinely provided to DHEC.	Condition 98 (g)	1 Electronic copy
12	Monitoring Program Records	Nonradiological Groundwater Monitoring Report	Lab computerized file and Barnwell vault Electronic copies routinely provided to DHEC	Condition 98(n)	1 Electronic copy
13	Monitoring Program Records	Environmental Monitoring Reports	Lab computerized file and Barnwell vault Electronic copies routinely provided to DHEC	Conditions 98(e) and 98(n)	1 Electronic copy
14	Performance Assessment Record	Groundwater modeling reports	Lab and Barnwell vault Paper	Condition 98(e)	Volume included in #10
15	Performance Assessment Record	Site characterization reports	Lab and Barnwell vault Paper	Condition 98(e)	Volume included in #10
16	Performance Assessment Record	Performance Verification Reports	Lab and Barnwell vault Paper	Conditions 98 (e, h, k, m, n, o, p)	Volume included in #10
17	Performance Assessment Record	Final Site Closure Plan Including Drawings	Lab and Barnwell Vault Paper	Condition 99	1.5ft^3 (paper)

7.2.2.2 Trench Construction/Maintenance Records

Trench construction and maintenance records are primarily stored in either the trench history or site stabilization files. The trench construction and design records are contained in the Barnwell site trench history files. The record types in these files include proposed and as-built trench drawings, trench qualification reports and construction inspection records. Trench and site maintenance records are currently maintained by the CNS Licensing Department in the site stabilization files.

7.2.2.3 Monitoring Program Records

Monitoring program records include radiological monitoring, non-radiological groundwater monitoring and water level reports as well as maintenance and construction records associated with sample point locations. The monitoring reports listed above are currently provided quarterly to DHEC. CNS will continue to provide the routine monitoring reports through the closure period. At the end of Phase I closure, the computer databases of groundwater monitoring and water level data will be provided.

7.2.2.4 Site Drawings

DHEC has previously received site drawings, which include trench-specific proposed and as-built drawings, on-site and off-site environmental sampling locations, burial trench locations, ancillary facility locations, land survey control point documentation, site utility locations, site topography and maximum water table surface configuration. At site closure, CNS will provide drawings showing the closed site configurations as well as microfilm copies of all of the above.

7.2.2.5 Performance Assessment Records

Performance assessment records include groundwater modeling, site characterization, final site radiological survey and other performance assessment reports as well as the site Closure Plan. These reports provide documentation to demonstrate compliance with performance objectives. CNS anticipates that a final performance objectives verification report will be generated and submitted at the end of the Phase I closure period.

7.2.3 Transfer Records Management

CNS has identified two classes of records involved in the transfer process: working copies and permanent copies. Working copies transferred to DHEC will be stored within an on-site facility. Permanent copies will be stored in a contracted off-site facility with proper environmental controls for long-term storage.

CNS plans to transfer records in paper, microfilm or electronic format. Most documents will be maintained on microfilm. For microfilm and paper records, a computer database index will be developed for efficient record retrieval.

Computer databases containing trench records and environmental data will be transferred to the custodial agency. These databases are routinely maintained by CNS and contain the most current trench inventory and up to date environmental data. CNS will provide the data and necessary software to read the databases during the record transfer. Since these databases are maintained by CNS, there is no additional costs for data transfer.

7.2.3.1 Records Processing

Microfilm has a long history of successful information storage and retention, is an acceptable medium in a court of law, and will last 25 to more than 100 years depending

on film type, handling and storage conditions. Microfilm technology is well accepted, standards are well-developed, and technologies for electronic indexing and transfer of microfilmed records to electronic media are in common use.

CNS proposes use of microfilm to store most working copies of CNS records. An electronic indexing system will be developed to ensure rapid retrieval of information. Some records due to size, format or condition may not be suitable to be microfilmed. These will be stored in their original format.

Storing data on microfilm requires document filming, film processing and a reader/printer to access records. CNS plans to continue filming its records, using CNS personnel to film and a contractor to develop the film, until site closure. After transfer of records, CNS recommends that subsequent records be filmed and processed by a certified laboratory.

7.2.3.2 Records Storage, Maintenance and Recovery

Any record storage system depends on establishing and implementing proper process controls to protect and maintain data integrity. CNS has established procedures and processes to address the following issues:

- records preparation and filming,
- legibility of filmed records,
- proper identification of records filmed,
- indexing, and
- long-term handling and inspection.

CNS currently uses an off-site storage facility that meets microfilm storage requirements. CNS plans to continue using such a facility for permanent records until the time of

site transfer. CNS recommends DHEC continue to maintain permanent records at such a facility.

7.2.3.3 Records Management Cost Estimate

The Records management costs in Table 7-3 include costs for lease of a microfilm reader/printer/digitizer; professional support for installation and training; and personnel costs for evaluating current microfilm, converting existing paper records to film and developing records management procedures and indexing system. During closure, transfer records not currently microfilmed will be converted to microfilm. Labor will be required to organize, film and index these records. Additional costs will be incurred by contractors to develop the film and for filming and processing of unusual record formats such as Barnwell site drawings.

Table 7-3
Records Transfer Costs (15 Months)

Records Transfer Costs	CNS Labor	$72,669
	Contractor	$1,223
	Equipment	$29,440
	Subtotal	$103,332
G & A Allocation		$6,200
	Subtotal	$109,532
Fee		$15,334
Total		$124,867

8.0 POST-CLOSURE OBSERVATION AND LONG-TERM CARE

This section outlines the overall site monitoring and maintenance program for post-closure observation as well as the long-term care (institutional control) period. Post-closure observation, which is assumed to occur during the first five years after completion of the Phase I and II closure periods, will involve the observation and monitoring required to ensure closure is complete and to verify performance objectives continue to be met.

The long-term care period has been divided into four stages: Stage I, which coincides with the thirty-six year in-region period (encompassing in-region operations, Phase II closure and Phase II post-closure observation); Stage II, the first 25-years of institutional control; Stage III, the second 25-year period; and Stage IV, the remaining 50-years of institutional control. Results from a site performance evaluation following each of the first three stages will determine whether monitoring and oversight can be reduced for subsequent periods of long-term care. After Stage IV, some limited controls, monitoring and maintenance may be appropriate, although, evaluations of long-term care fund adequacy in this document end with the institutional control period.

During the post-closure observation and long-term care periods, essentially the same manpower will be required for maintenance and monitoring. The five-year period of post-closure observation also includes funding for additional site performance evaluations and reviews as may be required to address regulatory review of the site decommissioning report. Final review of monitoring data and performance evaluations will enable CNS and DHEC to verify conformance to the performance objectives.

The maintenance activities specified in this plan assume a closed, stable site, entirely covered in grass. CNS also assumes hiring contracted labor and resources for any remediation.

CNS' evaluation of the long-term care fund conservatively assumes no decrease in level of monitoring and maintenance during the entire long-term care period. CNS has also estimated the potential costs of remediation scenarios.

8.1 Post-Closure and Long-Term Care Staff and Support

CNS proposes an on-site staff of one supervisor, three technicians and one clerical located at or near the disposal site to perform routine monitoring and maintenance work. The technicians will be qualified to operate the equipment needed to maintain the site grass cover, drainage conveyances and access roads. They will be trained to collect monitoring data and samples. At least one member of the staff will be qualified as a health physics technician, and one will have background in equipment maintenance. At least one individual on staff will be familiar with the on-site records storage and have the knowledge to retrieve records. Management support will provide back-up capabilities in the areas of environmental monitoring and site maintenance as well as records management. CNS assumes that sample analyses will be performed by a contracted laboratory.

For post-closure and custodial long-term care, additional resources will be required to support activities such as project management, environmental data and site performance evaluation, quality assurance, financial control, information systems and human resource support. It is expected that additional support labor will be required during post-closure for regulatory interaction. Staff will also require general supplies and materials (e.g. sampling and office supplies, tools, etc).

Security oversight will entail part-time weekend and after-hour coverage. Work day security will be managed by the staff. These costs are summarized in Table 8-1. A reduced level of security relative to Phase I closure is justified because by that time all trenches will be closed and secured.

Table 8-1
Long-Term Care and Post-Closure Observation Staff Annual Costs

	Post Closure	Long-Term Care
On-Site Staff Labor	$326,643	$326,643
Support Labor	$90,393	$90,393
Security Labor	$76,301	$76,301
Supplies / Materials	$21,760	$21,760
Total	$731,162	$686,974

8.2 Site Maintenance

Site maintenance will be required during the post-closure and long-term care periods. In long-term care, CNS expects maintenance requirements will decrease over time. However, in projecting long-term care fund adequacy, CNS conservatively assumes no decrease in maintenance costs.

Stage I and II of long-term care (the first 36 and 25 year periods, respectively) will require maintenance such as mowing, fertilizing, road grading and repair of erosion and occasional localized trench subsidence. Re-topsoiling and seeding will be performed as required. Periodic inspections of trench cap integrity should be performed to ensure early detection of trench cap degradation and other site maintenance needs. Frequency of inspections may be varied according to observed site stability. Grass mowing on trench caps and surrounding areas will be necessary to maintain healthy grass stands and prevent growth of shrubs and trees. Security fence inspections must also be conducted and repairs made.

The primary equipment necessary to maintain the site is listed in Table 8-2 with site maintenance equipment and material costs in Table 8-3. CNS assumes lease rates for all equipment except the farm tractor and mower. The lower annual costs during post-closure are due to the lack of equipment purchases during the post-closure observation periods.

Table 8-2
Long-Term Care Equipment

Backhoe Loader
Motor Grader
Pickup (2)
Farm Tractor
Mower

Table 8-3
Annual Site Maintenance Costs (non-labor)

	Post-Closure	Long-Term Care
Routine Maintenance	$134,359	$145,189

The required work for Stage III (the second 25-year period of institutional control) may decrease due to anticipated further stabilization of trench caps. Required maintenance should consist of no more than quarterly trench cap inspections and the repair of erosion and settling detected during these inspections. The perimeter fence should be inspected routinely and repaired if necessary. Grass mowing will continue to prevent growth of undesirable vegetation. Equipment needs will be the same as the first 25 years.

During Stage IV (the last 50 years) of long-term care, site maintenance should be significantly reduced. The inspection and repair of erosion caused by normal run-off will continue semi-annually. It is expected that grass mowing and fence repairs will be done on a quarterly basis. Although required maintenance will probably decrease, the annual equipment costs are conservatively assumed to be the same as earlier phases.

Enhanced caps may require repair if subsidence or large settlements occur. Repair will involve removing cap components down to the geomembrane. Then, if the geomembrane is severely strained, failed or below adequate grade, the substandard portion of the geomembrane will be removed and the underlying bentonite mat inspected and replaced, if necessary. Both geomembrane and bentonite will be repaired in accordance with the same quality assurance/quality control procedures used during original installation.

Such repair will require a geomembrane installation contractor and quality assurance consultant. CNS estimates cost for cap repair by conservatively assuming one repair every two years through post-closure and long-term care. This will result in a cost of about $15,000 per event, or an average annual cost of $7,500. These costs are incorporated into the estimate for routine site maintenance in Table 8-3.

Personnel and equipment to perform site maintenance and monitoring during the long-term care period have been identified in Section 8.1. Staff size and equipment have been selected to accomplish the expected site

maintenance including small trench repairs from settlement, general maintenance of access roads, upkeep of the buildings, equipment and security fencing, and maintenance of the drainage ways and surface water management basins. This staff will also collect samples for the monitoring programs.

CNS also assumes that approximately every 25 years during long-term care all fence will need to be replaced. Costs are provided in Table 8-4 below.

Table 8-4
Fence Replacement

		Per Event	Total
Fence Replacement	Labor + Materials	$170,000	$680,000

8.3 Other Facility Operating Costs

During post-closure and long-term care, the facility may incur costs due to taxes, insurance and regulatory fees. Such costs include property and real estate tax, property insurance and DHEC fees. Nuclear insurance policies are retained by CNS until site transfer at the end of Phase I post-closure. It is assumed that the State will obtain nuclear insurance for the facility at premiums equal to current amounts. Utility costs will also be incurred for the support facilities at the site. These long-term care and post-closure costs are summarized in Table 8-5.

Table 8-5
Annual Long-Term Care and Post-Closure Observation Facility Operational Costs

	Post-Closure	Long-Term Care
Utilities	$21,482	$21,482
Taxes	$104,219	$104,219
Insurance	$925,544	$925,544
License & Other Fees	$279,551	$275,829
Total	$1,330,796	$1,327,074

8.4 Long-Term Site Performance Evaluations

During the post-closure observation period, CNS has budgeted for on-going performance objectives evaluation and review to address regulatory review of the decommissioning performance objectives verification report. Additionally, at the end of each long-term care period phase, CNS budgets for an evaluation of site performance objectives. Evaluations during long-term care entail review of current environmental monitoring data, site maintenance records and topographic data to ensure continued regulatory compliance and to determine whether levels of monitoring and maintenance should be modified for the subsequent phase. At the end of long-term care, these evaluations will serve to determine proper final site disposition.

CNS envisions hiring consultants to review environmental data and perform site performance assessment. Part of this effort would include a site radiological survey (comparable to the final site survey in closure), topographic survey and other remote sensing, as appropriate. Aerial topographic land survey and photographs will be compared against previous data to check general erosion rates, silt accumulation in the water management basins and surface runoff flow patterns. Post-closure performance evaluation costs are summarized in Table 8-6. Long-term site performance evaluation costs are summarized in Table 8-7.

Table 8-6
Post-Closure Site Performance Evaluation Costs

Performance Evaluation and Review	Labor	$227,765
	Contractor	$320,698
Total		$548,463

Table 8-7
Long-Term Care Site Performance Evaluation Costs

		Per Event
Performance Evaluation (3 events)	Labor	$250,542
	Contractor	$349,458
Site Radiation Survey (3 events)		$150,000
Aerial Survey/Remote (3 events)		$15,000
Total		$765,000

8.5 Potential Long-Term Remedial Actions

CNS considers two potential remediation scenarios during the long-term care period. One involves pumping and treating groundwater near the headwaters of Mary's Branch to remove unacceptable levels of groundwater contamination. The other involves replacing enhanced cap on the disposal site. These remediation scenarios are provided for information. Since they are not expected to occur, these scenarios are not included in the evaluation of long-term care fund adequacy.

8.5.1 Pump and Treat Scenario

CNS has measured tritium in Mary's Branch creek and evaluated potential dose rates to an off-site individual. CNS has also measured low concentrations of carbon-14 in groundwater beneath the stream. Since there is no known user of water at the location where the stream crosses the CNS property boundary, there is no measurable dose rate to an off-site individual immediately downstream of the Barnwell site.

Should levels of tritium become sufficiently large during the institutional control period, the site custodian and DHEC may find it necessary to treat groundwater before it enters Mary's Branch creek. A typical pump and treat system would be composed of a line of extraction wells perpendicular to groundwater flow, placed and designed to capture the highest level of radioactivity. Using these wells, water containing tritium and carbon-14 can be extracted and evaporated. The quantity of water removed can be controlled to manage stream concentration levels.

Treatment costs depend upon volumetric flow rate. Using baseline information from Fulbright et al., 1996, a plant treating 25 gpm of tritiated water will cost $17 million over 20 years (in 1996 dollars).

Based on recent environmental monitoring data, CNS would need to treat approximately 8.3 gpm to eliminate areas of high tritium groundwater entering Mary's Branch. The cost of treating this

water is $7 million over 20 years, assuming that treatment plant costs are directly proportional to volumetric flow rate. If CNS were to treat all waters associated with the projected tritium plume, the required treatment volumetric flow rate is approximately 44 gpm, and the cost over 20 years is $30 million.

8.5.2 Cap Replacement Scenario

Long-term enhanced cap degradation, excessive settlements or desirable new capping technologies may lead to a decision to replace or upgrade a large part of or all enhanced caps at the Barnwell site. Costs for this scenario are described below.

CNS envisions a cap upgrade/repair would involve excavation down to the geomembrane liner, and segregation of cover component materials for later re-use. Cap barrier components (clay liner, bentonite mat and geomembrane) would be replaced or enhanced, and overlying cover components would then be reinstalled. CNS estimates that remedial cap replacement/ enhancement could cost as much as $150,000/acre, comparable to the price of recent cap enhancement projects. Assuming total cap enhancement acreage at 125 acres, total site cap replacement could cost $18.75 million.

8.6 Site Monitoring

Proposed monitoring programs for the long-term care period emphasize groundwater monitoring. Based on the site's expected performance and the fact that the amount of radioactivity will be decreasing, CNS expects the program can be reduced during institutional control at the 25 and 50-year points. This possibility will be evaluated during the periodic site performance evaluations. CNS cost estimates assume no decrease in monitoring from the level established at site closure during the entire long-term care period. CNS assumes the use of a contracted laboratory for sample analysis and custodial personnel for sample collection. Monitoring program costs are summarized in Table 8-8.

Table 8-8 Post-Closure/Long-Term Care Annual Site Monitoring Costs	
Sample Analysis	$498,564
Environmental Program Waste Disposal	$62,200
Total	$560,767

8.6.1 Radiological Monitoring

The long-term care and post-closure observation environmental monitoring program is summarized in Table 8-9. Data from the environmental monitoring program provides CNS with long-term trends, areal extent and concentration of radioactivity in migration.

Additionally, CNS has analyzed and attempted to measure potentially mobile radionuclides in groundwater and air. Environmental and characterization data trends show the following:

- Tritium appears to be associated with most low-level radioactive waste trenches and migrates with groundwater.
- The highest tritium concentrations appear to be decreasing.
- Low concentrations of carbon-14 are measured downgradient of the disposal site.
- A low concentration of technetium-99 has been measured at one location down gradient of disposal trenches.
- There is no detectable quantity of gaseous phase radionuclides.

Based on these identified trends and knowing that radioactivity will decrease with time, CNS proposes to decrease the number of monitoring points during Phase I site closure. For post-closure monitoring, CNS recommends continuing monitoring at approximately site closure levels.

For planning purposes, CNS assumes 120 monitoring wells will be retained for post-closure and long-term care monitoring. Four stream locations have been selected on Mary's Branch; each location will be sampled quarterly for surface water and annually for sediment. Trench standpipes/sumps will be sampled quarterly. Surface soil samples will also be collected quarterly at selected boundary, on-site and off-site locations.

Monitoring locations will be chosen from the set of current monitoring locations. The majority of monitoring locations will be located within the disposal area and downgradient from the disposal site. The sample locations will be chosen so most areas on and downgradient of the disposal site will be sampled. Final locations will be chosen with SCDHEC concurrence.

Carbon-14 will be analyzed annually in nonradiological monitoring program wells. CNS will use gross beta as a surrogate measure of carbon-14 in groundwater for the remaining quarters. Gross beta is also used to monitor for other beta emitting radionuclides such as technetium-99.

8.6.2 Non-Radiological Monitoring

In addition to radiological groundwater monitoring, during the post-closure and long-term care periods, non-radiological groundwater monitoring will continue as shown on Table 8-9. This level of monitoring is comparable to that recommended during the Phase I closure period in Section 6.5. The sampling frequency may be reduced at later phases. A reduction in the frequency of sampling is justified by long-term trends of non-radiological constituents having the potential to migrate in groundwater. Volatile organic compounds have been identified in monitoring wells downgradient from the Barnwell site. Chem-Nuclear evaluates non-radiological constituent trends and reports them to DHEC on a quarterly basis. Non-rad groundwater concentrations have remained relatively constant over the last three to five years, with no new significant compounds identified. Therefore, monitoring will be performance monitoring and not detection monitoring. Since the parameters are well documented, the frequency of monitoring could be reduced and still provide adequate information on constituent concentrations (NRC, 1989).

Table 8-9
Long-Term Care Monitoring Program

Phase I

Sample Description	Locations	Type	Media	Frequency	Analysis
Wells [1,2]	120	Grab	Water	Quarterly	Gross-Alpha-Beta, Gamma Isotopic and Tritium
Wells [1,2]	28	Grab	Water	Annually	Carbon-14
	28	Grab	Water	Quarterly	pH, Conductivity, Total Organic Carbon, Volatile Organics
Wells [1,2]	16	Grab	Water	Annually	Acids, Base/Neutrals, Pesticides/PCB's, Phenols, Cyanide, Metals
Surface Water [3]	2	Grab	Water	Annually	Carbon-14
Surface Water [3]	4	Grab	Water	Quarterly	Gamma Isotopic and Tritium
Surface Water [3]	2	Grab	Water	Quarterly	pH, Conductivity, Total Organic Carbon, Volatile Organics
Surface Water [3]	2	Grab	Water	Annually	Acid, Base/Neutrals, Pesticides/PCB's, Phenols, Cyanide, Metals
Observation Sumps [2, 4]	151	Grab	Water	Quarterly	Gamma Isotopic and Tritium
Surface Soil	20	Grab	Soil	Quarterly	Gamma Isotopic and Tritium
Sediment [3]	4	Grab	Sediment	Annually	Gamma Isotopic and Tritium
Samples of Opportunity [5]	100	Grab	Various	Quarterly	Gamma Isotopic and Tritium

Notes:
(1) Includes selected wells from the existing monitoring programs annually.
(2) Water levels measured quarterly.
(3) Subset of current locations as the current monitoring program.
(4) Sump samples are collected when water is available.
(5) Samples deemed desirable by custodian.

8.6.3 Managing Environmental Program Wastes

As a result of the environmental monitoring program, radioactive waste will be generated that will require processing and disposal. The radioactive waste will be in two forms: water from the groundwater monitoring program and dry active waste from sample collection and analysis activities.

Guidelines for management of the water are summarized as follows:

- Purge water removed from environmental wells during sample collection that has a concentration of tritium less than or equal to 50% of the National Primary Drinking Water Standard Maximum Contaminant Level (MCL), will be discarded at the sample location. This applies to monitoring wells only.

- The maximum volume to be discarded per well shall not exceed 50 gallons. If the volume exceeds 50 gallons, the volume above

50 gallons will be placed into a water management basin (such as the West Pond).

- Purge water with a concentration of tritium greater than 50% of the MCL will be treated for disposal.

- The previous quarter's environmental data will be used to determine which wells fall into the save or discard categories.

- Water collected for analysis will also be managed by these criteria. Upon completion of the analyses, if the only nuclide present is tritium, and its concentration is less than or equal to 50% of the MCL, the sample water will be discarded in an approved water management pond. If other nuclides are present or if the tritium concentration is greater than 50% of the MCL, it will be treated and the remaining residue will be sent for processing and disposal. The current treatment occurs at the Duratek Bear Creek Facility. Cost estimates provided assume Bear Creek treatment.

- Water acquired during the construction and/or re-development of environmental monitoring wells will be analyzed on a case-by-case basis to determine tritium concentration. If the concentration is less than or equal to 50% of the MCL, the water will be placed into the "West Pond" or in another approved water management pond. If the concentration is greater than 50% of the MCL, it will be treated.

- All water collected from trench monitor pipes and sumps will be treated.

The annual volume of water produced by the environmental sampling program that would require treatment based on currently approved guidelines is approximately 6,900 gallons. Also, the solid radioactive waste consisting of sampling supplies, protective clothing and sample residuals will be about three 55- gallon drums

of dry active waste annually. The annual long-term cost of processing, transport and disposal is estimated at $62,200.

8.7 Post-Closure Observation and Long-Term Care Cost & Schedule

Post-closure observation and long-term care period site maintenance and monitoring activities and associated costs have been discussed in the preceding parts of Section 8. Tables 8-10 and 8-11 summarize annual costs, respectively, for post-closure and long-term care activities. Costs of periodic performance evaluation and fence replacement are provided in Tables 8-4, 8-6 and 8-7. For cost estimating purposes, it is assumed that no disposal trenches are available for placement of site-generated waste during either post-closure observation or long-term care.

Table 8-10
Post-Closure Observation Costs

	Routine Annual Costs
Labor	$489,337
Supplies/Materials	$25,760
Site Maintenance Equipment	$134,359
Rad and Nonrad Sample Analysis	$498,564
Radwaste Processing	$62,200
Performance Objectives Verification Support	$109,693
Utilities	$21,482
Other Facility Support Costs (DHEC fees, taxes, insurance)[1]	$1,309,314
Subtotal	$2,650,709
G&A	$80,484
Subtotal	$2,731,193
Fee	$199,063
Total	$2,930,256

[1] G&A and fee not applied to these costs.

Table 8-11
Long-Term Care Costs

	Routine Annual Costs	Non-Routine Costs			
		at 25 Years	at 50 Years	at 75 Years	at 100 Years
Labor	$445,149				
Supplies/Materials	$25,760				
Site Maintenance Equipment	$145,189				
Rad and Nonrad Sample Analysis	$498,564				
Radwaste Transport and Disposal	$62,200				
Utilities	$21,482				
Facility Support Costs (DHEC Fees, taxes, insurance)[1]	$1,305,592				
Fence Replacement (every 25 years)		$170,000	$170,000	$170,000	$170,000
Microfilm Records Reprocessing (every 25 years)		$10,000	$10,000	$10,000	$10,000
Site Radiation Surveys (25, 50 and 100 years)		$150,000	$150,000		$150,000
Performance Assessment Evaluation (25, 50 and 100 years)		$600,000	$600,000		$600,000
Aerial Land Survey (25, 50 and 100 years)		$15,000	$15,000		$15,000
Subtotal	$2,503,936	$945,000	$945,000	$180,000	$945,000
G&A Allocation	$71,901	$56,700	$56,700	$10,800	$56,700
Subtotal	$2,575,837	$1,001,700	$1,001,700	$190,800	$1,001,700
Fee	$177,834	$140,238	$140,238	$26,712	$140,238
Total	$2,753,671	$1,141,938	$1,141,938	$217,512	$1,141,938

[1] G&A and fee not applied to these costs

8.8 Financial Assurance

Chem-Nuclear entered into a 99-year Lease Agreement with the State of South Carolina on April 21, 1971, to lease a 17.2 acre plot of land, previously deeded to the State by Chem-Nuclear for the purpose of burial of radioactive waste. Under this agreement, Chem-Nuclear agreed to operate in accordance with its license application, the conditions of its License 097 and the requirements of the AEC (now NRC) and the State. The agreement also established a fund for the long-term care of the site. Chem-Nuclear agreed to pay eight cents into the fund for every cubic foot of waste received for burial.

A second Lease Agreement was executed on April 6, 1976, replacing the previous agreement and expanding the lease area to its present 235 acres; the other conditions of the lease remained substantially the same. However, the long-term care fund payment was increased to sixteen cents per cubic foot. The lease agreement was amended on September 11, 1979, to change the long-term care fund payment to fifty-five cents per cubic foot from September 1, 1979, through April 5, 1980; seventy-five cents per cubic foot from April 6, 1980, through April 5, 1981, and one dollar per cubic foot from April 6, 1981, through April 5, 1982. Payments after April 5, 1982, have been established through negotiations between Chem-Nuclear and the State. Pursuant to those negotiations, the agreement was again amended to stipulate a payment to the long-term care fund of two dollars per cubic foot from April 6, 1982, through April 5, 1983; two and one quarter dollars per cubic foot from April 6, 1983, through April 5, 1984; and two and one half dollars per cubic foot from April 6, 1984, through April 5, 1985. The current rate of payment was set on April 5, 1985 at $2.80 per cubic foot of waste.

This section provides updated information on the planned activities required to provide surveillance and maintenance of the buried radioactive waste during post-closure and long-term care. This information has been used to make an evaluation of the adequacy of the long-term care fund. CNS based its long-term care fund evaluation on the expected operations scenario shown in Figure 1-1 and the assumptions outlined below.

- Beginning fund balance of approximately $24.3 million as of July 1, 2005.

- Addition of $20,472,134 repayment to the long-term care fund from the South Carolina Department of Revenue in accordance with South Carolina FY 2005/2006 Budget, Part 1B, Section 73.17 (SR: Increased Enforcement Collections). The State Treasurer will disburse funds to the long-term care fund on a quarterly basis beginning December 31, 2005.

- Three years of continued operations at waste volumes projected in the 2005 Closure Plan followed by thirty years of in-region operations at

8,000 ft^3 per year. The long-term care fund contribution rate is assumed to be $2.80 per cubic foot.

- Based on the FY 2004/2005 Least Cost Operating Plan (CNS, 2004), the site is projected to operate at a deficit in FY 2008/2009. The deficit amount (not including routine costs budgeted from the decommissioning fund) will be a one-time payment from the long-term care fund of approximately $2.3 million. S.C. Code Ann. §48-46-40(B)(7)(a)(1976) requires the site operator to propose a plan for "suspended operations" if it appears that waste receipts will not cover site operator's allowable costs and operating margin.

- Beginning in FY 2008/2009 concurrent with in-region operations, fifteen months of Phase I closure period paid from the decommissioning trust fund. Decommissioning trust fund is sufficient for the 15-months of closure activities.

- After completion of Phase I closure activities, the cost of Phase II closure ($2,258,500) is reserved from the remaining decommissioning trust fund balance.

- Following the Phase I closure period, five years of Phase I post-closure observation during which the $2,930,256 annual costs of maintenance and monitoring (Table 8-10) are withdrawn first from remaining decommissioning funds and then the long-term care fund.

- Following post-closure, approximately 24 years (comprising the remaining in-region operations period) of long-term care monitoring and maintenance expense for areas closed during the Phase I closure period. This expense will be withdrawn from long-term care fund.

- During the one year of Phase II closure, the long-term care fund continues to pay for long-term care maintenance and monitoring activities.

- Five years of Phase II post-closure observation withdrawn from long-term care (annual costs estimated in Table 8-10).

- After Phase II post-closure, one hundred years of institutional control at an annual routine cost of approximately $2.75 million provided in Table 8-11 with non-routine costs included at intervals defined in Table 8-11.

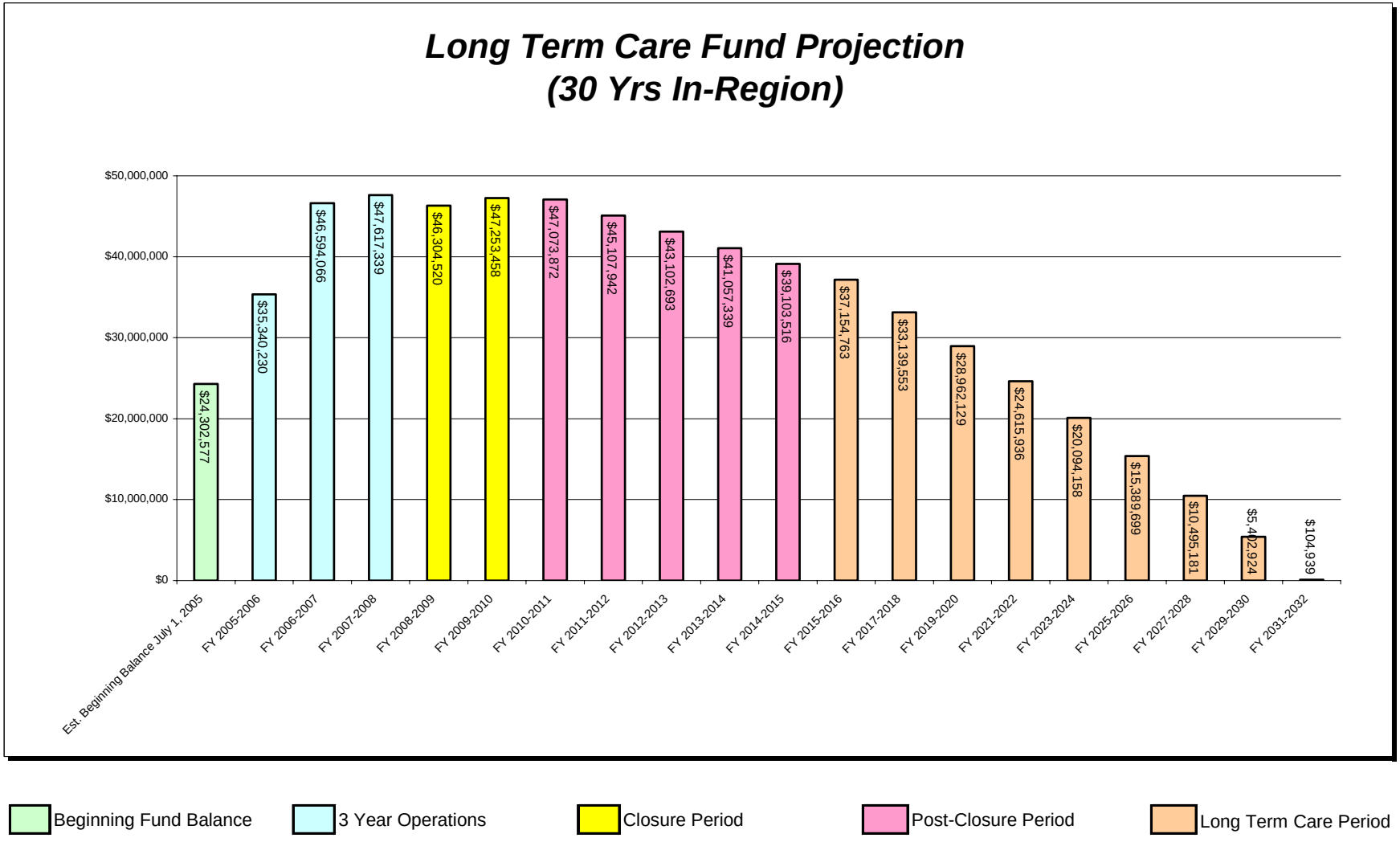
- Long-term care fund interest is assumed at 2%, which is the projected "real" long-term growth of the fund after inflation.

Based on the above assumptions, the planned activities and associated cost estimates, the long-term care fund is sufficient through FY2031-2032 as shown in Figure 8-1. The South Carolina General Assembly has committed to replenishing the long-term care fund to the level of 2001 as required in accordance with the South Carolina FY2005-2006 Budget, Part 1B, Section 72.62 (GP: Restore Barnwell Funding).

The findings of the long-term care fund evaluation depend on several key assumptions, which significantly impact conclusions about long-term care funding. Key assumptions include the following:

(1) Rate of return for long-term care fund investments.
(2) Need for and cost of nuclear liability insurance for State of South Carolina.
(3) Rate of reduction in monitoring and maintenance during institutional control.
(4) Level of security required during institutional control.
(5) Starting date for and length of period requiring funding from the long-term care fund. After institutional control, limited funding may be needed for on-going passive control.
(6) Amount of site operations cost deficits made up from long-term care fund.
(7) Potential for and extent of remedial actions. CNS does not project a need for remedial actions based on experience to date and ERPV projections.
(8) Other site-related insurance costs for the State of South Carolina.

FIGURE 8-1


Long Term Care Fund Projection
(30 Yrs In-Region)
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
$0
$24,302,577
$35,340,230
$46,594,066
$47,617,339
$46,304,520
$47,253,458
$47,073,872
$45,107,942
$43,102,693
$41,057,339
$39,103,516
$37,154,763
$33,139,553
$28,962,129
$24,615,936
$20,094,158
$15,389,699
$10,495,181
$5,402,924
$104,939
Est. Beginning Balance July 1, 2005
FY 2005-2006
FY 2006-2007
FY 2007-2008
FY 2008-2009
FY 2009-2010
FY 2010-2011
FY 2011-2012
FY 2012-2013
FY 2013-2014
FY 2014-2015
FY 2015-2016
FY 2017-2018
FY 2019-2020
FY 2021-2022
FY 2023-2024
FY 2025-2026
FY 2027-2028
FY 2029-2030
FY 2031-2032
Beginning Fund Balance
3 Year Operations
Closure Period
Post-Closure Period
Long Term Care Period

9.0 REVIEW OF CLOSURE PERFORMANCE OBJECTIVES

This section lists the License 097 closure performance objectives along with a description of the method by which CNS plans to comply with each objective. The methods and assumptions described below form the basis for identified tasks and costs of closing the disposal site. Specific sections of the Closure Plan are referenced, as appropriate, to provide a more complete discussion. Costs for implementation of performance objectives review falls under the performance objectives assessment task as well as other specific closure tasks described in Section 6.

9.1 Objective A

"Bury all waste in accordance with the requirements of the license."

CNS operates the Barnwell site under License 097. To meet license requirements regarding waste burial, CNS has established procedures, trained its personnel in their use, and assigned specific individuals responsibility for ensuring CNS compliance.

To help assure that the requirements of the licenses are met, DHEC has assigned a representative at the facility to inspect incoming shipments and burial operations. DHEC engineers also inspect and approve each disposal trench during its construction. DHEC performs frequent inspections of the CNS operations and records, including periodic formal audits.

In addition to DHEC's inspections, CNS conducts an internal audit program to evaluate compliance with licensing requirements. Audit results are made available for review by regulatory agencies. The regulatory inspection programs are described further in Section 3.1.3.

During site closure, CNS will evaluate Objective A against its applicable procedures to confirm that all applicable requirements are met. Chem-Nuclear will also review its inspection documents, particularly those that

have been performed by DHEC, to verify that all outstanding compliance issues have been resolved.

The narrative justifying meeting Objective A will include a description of how CNS complied with each license condition applicable to waste disposal. The narrative will also include a summary of the trench construction process, summary of HIC certification and a description of how the engineered covers minimize the potential movement of radioactivity from the disposal site.

In summary, CNS has assumed that Objective A is met when (1) CNS has complied with all applicable waste disposal requirements of the 097 license, (2) there are no remaining unresolved DHEC recommendations regarding burial of waste, and (3) all waste has been disposed in the closed portion of the disposal site.

9.2 Objective B

"Dismantle, decontaminate, as required, and dispose of all structures, equipment, and materials that are not to be transferred to the site custodian."

Most structures within the restricted area fence will be dismantled and disposed on site. Contaminated materials will be properly buried. The on-site vehicles and heavy equipment will be decontaminated and removed from the facility. The anticipated disposition of each building and structure and methods proposed for decommissioning are discussed in Section 6.1.

Chem-Nuclear plans to remove, decontaminate and dispose of all structures and materials that are not transferred to the site custodian. Certain contaminated materials such as buried contaminated soils may be left in place provided that CNS can meet a 25 mrem/yr and ALARA requirement.

Chem-Nuclear plans to show compliance with this requirement by

a) Measuring surface soil contamination levels and comparing the results with available standards for soil concentrations such as applicable regulatory guidance from the Nuclear Regulatory Commission,
b) Using applicable models such as RESRAD, or
c) Direct measurement.

Chem-Nuclear has assumed that this objective is met when all structures described in Section 6.1 and equipment not transferred to the custodial agency have been removed from the site surface and when the 25 mrem/yr and ALARA requirement has been documented and provided to DHEC.

9.3 Objective C

"Document the arrangements and the status of the arrangements for orderly transfer of site control and for long term care by the government custodian. Also document the agreement, if any, of state or federal governments to participate in, or accomplish, any performance objective. Specific funding arrangements to assure the availability of funds to complete the site closure and stabilization plans must be made."

The State of South Carolina owns the property that CNS uses for the disposal of low-level radioactive waste. Chem-Nuclear has a long-term Lease Agreement with the State Budget and Control Board for use of this land. At completion of Phase II post-closure observation, this property will revert to State ownership and management in accordance with the site transfer mechanisms discussed in Sections 7.0 and 11.0.

No performance objective to be accomplished by the State of South Carolina or any agency of the federal government has been identified. Therefore, CNS will initiate the legal process of transferring site control by drafting legal documents for DHEC concurrence. Upon receiving DHEC concurrence, CNS will finalize the legal document and submit it to the Budget and Control Board for approval. Upon completion of closure,

CNS will document the arrangements and agreements for orderly transfer of site control for long-term care by the government custodian. CNS has assumed that this objective is complete when the documentation which is described in Section 7.0 is submitted to DHEC.

A decommissioning fund has been established by means of the Trust Agreement between CNS and the State Budget and Control Board. CNS and DHEC evaluate the adequacy of these funds at each Closure Plan update. Closure funding is discussed in Section 6.11.

9.4 Objective D

"Direct gamma radiation from buried wastes should be essentially background."

Direct gamma surveys of completed trenches are conducted when trenches are closed. In addition, a final closed site survey will be performed during closure as described in Section 6.1.4. A final closed site survey report will be submitted to DHEC. This report will describe methodology, results and an analysis to show that “direct gamma radiation” from the buried waste when measured above the land surface is essentially at background. Objective D will be complete when CNS submits this report to DHEC.

9.5 Objective E

"Demonstrate by measurement/and or model during operations and after site closure that concentrations of radioactive material which may be released to the general environment in ground water, surface water, air, soil, plants, or animals will not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public."

Before closure, CNS plans to evaluate current environmental monitoring data and repeat an Environmental Radiological Performance Verification (ERPV). This study will use the latest environmental data to project

disposal site radiological performance. Methods will be similar to those presented in CNS 2003, and summarized in Section 6.6.

New data collected since the earlier ERPV will increase the certainty of the environmental radiological performance projection of the disposal site. This new analysis will include a discussion of ERPV uncertainty where warranted.

Chem-Nuclear has assumed that Objective E is complete when a report documenting the methodology, data and results of the ERPV is submitted during the site closure, and the analysis shows that environmental measurements and model projections show concentrations of radioactive materials in groundwater and surface water will not result in an annual dose exceeding the equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public.

9.6 Objective F

"Render the site suitable for surface activities during custodial care. Planned custodial care may be limited to activities such as vegetation control, interim maintenance, and environmental monitoring. However, use of the site surface for activities such as parking lots may be planned. Final conditions at the site must be acceptable to the custodial agency and compatible with its plans for the site."

Chem-Nuclear has provided a proposed final topography in Figure 6-1. In general, the topography will be gently sloped and vegetated to minimize erosion. Erosion rate will be sufficiently low to not affect the disposal site performance for a 500 year period.

Chem-Nuclear has assumed Objective F will be met when CNS completes final topography construction to lines and grades approved by DHEC and demonstrates that projected average erosion rate will not affect the disposal site performance for a period of 500 years. This analysis will be included in a report to DHEC.

9.7 Objective G

"Demonstrate that all trench bottom elevations are above water table levels, taking into account the complete history of seasonal fluctuations."

CNS designs trenches at the Barnwell site to ensure at least five feet of separation between trench bottom and maximum recorded historical water table level. In 1998, a new high water table was observed, establishing a new water table baseline at the site. CNS will use this baseline to design future trenches unless or until a new high is recorded.

The current environmental monitoring program is designed to monitor the water table around the disposal area. Chem-Nuclear will maintain sufficient numbers of monitoring wells to measure the water table elevation in the disposal area. Additionally, Chem-Nuclear has made disposal site design changes to minimize infiltration through disposal trenches, and has built water management ponds to separate ground water recharge from trench areas to the extent reasonable.

To address Objective G, Chem-Nuclear will produce documentation to show that engineering improvements to the disposal site will minimize the potential for water table encroachment on the trench bottoms. To the extent of available data, CNS will also produce documentation to show it has constructed trenches according to the known high water table at the time of trench construction. Furthermore, this document will show that the impact of occasional water table encroachment should not impact the overall disposal site radiological performance. This document will be produced during site closure.

9.8 Objective H

"Eliminate the potential for erosion or loss of site or trench integrity due to factors such as groundwater, surface water, wind, subsidence, and frost action. For example, an overall site surface water management system must be established for humid sites to drain rainwater and snowmelt

away from the burial trenches. All slopes must be sufficiently gentle to prevent slumping or gullying. The surface must be stabilized with established short-rooted grass, rock, riprap, or other measures. Trench caps must be stabilized so that erosion, settling, or slumping of caps does not occur."

Surface water erosion will be minimized by gentle sloping, vegetation, and proper water management as described in Section 6.2.2. Stormwater will drain away from burial trenches to the surface water management basins shown on Figure 6-1.

During the closure period, CNS will confirm that average soil loss rate by measurement does not impact the enhanced cap performance over a 500 year period. These measurements will be conducted for a number of different storm events and will be documented by CNS. The measurements will be used to determine average soil loss rates, and these rates will be used to estimate loss of enhanced cap thickness over a 500 year period.

Enhanced caps have been designed so sheet flow runoff velocities are sufficiently low so gully erosion should not occur in areas of concentrated flow. However, CNS anticipates gully formation in areas having inadequate vegetation, especially after cap construction. During the closure period there will be appropriate time to remediate areas susceptible to gully formation.

Chem-Nuclear has collected and compiled trench cap settlement and subsidence data. This data is provided to DHEC in routine letter reports. During closure, CNS will compile available data on trench cap settlement and subsidences. This data will be used to confirm required methods and appropriate resources for repair and remediation of settlements and subsidences in completed trench caps.

Chem-Nuclear has assumed Objective H is complete when CNS has produced documentation to show erosion rates on completed trench caps are sufficiently low to not impact their performance in 500 years.

9.9 Objective I

"Demonstrate that trench markers are in place, stable, and keyed to benchmarks. Identifying information must be clearly and permanently marked."

CNS uses a grid system at the site for horizontal control of site features and trench location. A set of permanent CNS benchmarks has been established across the licensed disposal area for use during surveying, as described in Section 6.4. The system uses Monuments SRO No. 123 and No. 128 to form a north/south baseline. This baseline, approximately 10^{o} 10' west of magnetic north, forms the western boundary of the site's current restricted area.

The trench corner markers are located and emplaced using the reference monuments and benchmarks discussed above. Each corner of each trench will be identified with a marker, and trench identification markers will be installed for each trench with the information prescribed in Section 6.2.3.

During site closure CNS will verify and document locations of trench markers. Each marker will be located and provided in a map. This map and documentation will serve to verify completion of Objective I.

Chem-Nuclear assumes Objective I is satisfied when the documented location of each trench marker is provided to DHEC.

9.10 Objective J

"Compile and transfer to the Department complete records of site maintenance and stabilization activities, trench elevation and locations, trench inventories, and monitoring data for use during custodial care for unexpected corrective measures and data interpretation."

Waste disposal as well as environmental monitoring data are routinely transmitted to DHEC monthly and quarterly. CNS and DHEC share trench drawings and construction information throughout the evaluation, approval, construction, use and completion stages of each trench. Complete sets of these and other records described in Section 7.2 will be transferred during the closure period.

Chem-Nuclear currently microfilms and verifies most quality assurance records in accordance with methods recognized by DHEC. Microfilmed records as well as those records that cannot be microfilmed will be provided to DHEC.

Certain trench inventory and routine environmental monitoring data are maintained by CNS in electronic format. These electronic files will be provided to DHEC before the end of site closure.

Certain site characterization (geologic) samples have been retained by CNS. Additionally, environmental samples are currently retained by CNS for five years after they are collected. These samples will be provided to DHEC during site closure.

Chem-Nuclear assumes Objective J is complete when a copy of the microfilmed quality assurance records, records that cannot be microfilmed, electronic data and samples described above are provided to DHEC.

9.11 Objective K

"Establish a buffer zone surrounding the site sufficient to provide space to stabilize slopes, incorporate surface water management features, assure that future excavation on adjoining areas would not compromise trench or site integrity, and provide working space for unexpected mitigating measures in the future. The buffer zone must also be transferred to the custodial agency. The buffer zone may generally be less than 300 feet but not less than 100 feet."

A 100-foot buffer zone has been maintained within the current licensed disposal area boundary. CNS' plan for boundary revisions and buffer zone for long-term institutional control are described in Section 6.7. The boundary will be revised to provide sufficient space to manage surface water, maintain site surface stability and for monitoring. CNS proposes to transfer all land within the proposed boundary to the State of South Carolina.

9.12 Objective L

"Provide a secure passive site security system (e.g., a fence) that requires minimum maintenance."

A fence will be installed around the closed disposal site, providing a passive security system. Fencing specifications and physical security of the site are discussed in Section 6.1.6.

The level of post-closure and long-term care security is explained in Section 8.1. Chem-Nuclear assumes that the physical barriers described in Section 6.1.5 provide adequate passive site security in accordance with Objective L.

9.13 Objective M

"Stabilize the site in a manner to minimize environmental monitoring requirements for the long term custodial phase and develop a monitoring program based on the stabilization plan for implementation by custodial agency."

Monitoring during long-term care is described in Section 8.6, including a brief discussion of the planned monitoring well population. CNS proposes to significantly reduce monitoring during closure and long-term care. CNS will perform an evaluation and select monitoring wells for long-term monitoring. The long-term program will be developed based on accepted environmental monitoring programs and practices incorporating CNS' detailed understanding of site geohydrologic characteristics.

Chem-Nuclear assumes that Objective M is met when it develops and submits a monitoring program for the long-term custodial phase meeting the description in Section 8.6. Deliverables will include a monitoring program document and a standard operating procedure.

9.14 Objective N

"Investigate the causes of any statistical increases in environmental samples which have occurred during operation and stabilization. In particular, any evidence of unusual or unexpected rates or levels of radionuclide migration in or with the groundwater must be analyzed and corrective measures implemented."

CNS notifies DHEC when environmental data indicate changes in radiologic conditions at the site. In the event of unexpected changes, DHEC is immediately notified. For small and expected variations, DHEC is informed by normal reporting procedures.

Based on CNS findings of above-background radioactivity, CNS has implemented corrective measures. In 1991, CNS started installing enhanced caps. So far, CNS has covered approximately 96 acres of trench as described in Section 6.2.1. As required by License 097, CNS will cover all existing trenches with enhanced caps.

Chem-Nuclear plans to operate an environmental monitoring program until the disposal site becomes the responsibility of the state custodial agency. During closure, as it has during operation, CNS will investigate increases in environmental sample analysis results. The current procedure and practices have been successful in managing changes in environmental sample analysis results.

Before the end of the closure period, CNS will investigate unexplained causes of increases in environmental sample analysis results. Chem-Nuclear has assumed that Objective N is satisfied if there are no known new unexpected and unexplained increases in environmental sample

analysis results at the time of site closure. Documentation of environmental monitoring data trends showing expected environmental monitoring results will be provided to DHEC to satisfy requirements of Objective N.

9.15 Objective O

"Eliminate the need for active water management measures, such as sump or trench pumping and treatment of the water to assure that wastes are not leached by standing water in the trenches."

The final grading and stabilization of the site will include proper sloping, topsoiling, and vegetation to minimize infiltration. These actions and enhanced caps will minimize infiltration of water into the trenches and reduce or eliminate the need for pumping or treatment of trench water. CNS has observed little or no water accumulation in trenches after enhanced cap installation.

Chem-Nuclear will provide DHEC with documentation that show, based on environmental measurements, that there is no water accumulation in trenches. Chem-Nuclear assumes that this document will satisfy the requirement of Objective O for site closure.

9.16 Objective P

"Evaluate present and zoned activities on adjoining areas to determine their effect on the long-term performances of the site and take reasonable action to minimize the effects."

Immediately west of the disposal facility, Barnwell County is developing an industrial park. CNS has and will continue to interface with the development board to determine potential impacts to long-term site performance. CNS knows of no other significant developments planned for areas adjoining the facility.

To meet the requirement of Objective P, CNS will network with Barnwell city and county officials during the site closure period. Chem-Nuclear will provide documentation to DHEC about any proposed changes in land use and their potential effect on long-term performance and custodial care of the disposal site. Chem-Nuclear has assumed Objective P will be complete after completion of the above documentation.

10.0 REASSESSMENT OF OPERATING PRACTICES

CNS performed a reassessment of site operations in conjunction with preparing this Closure Plan revision. This reassessment is intended to identify site improvements and activities that may contribute to the objectives of this plan. Current and relevant recommendations from recent closure plans are discussed below.

10.1 Trench Construction and Disposal Operations

Recommendation: Evaluate trench design, construction and disposal methods to address potential low-volume site operations. In-region only operations may involve as little as 8,000 ft^3 per year. To operate effectively and compliantly at such low volumes, design and operational modifications may be necessary.

Status: Conceptual approaches for in-region period trench design and operations have been discussed with DHEC.

10.2 Enhanced Caps

Recommendation: CNS should continue installing enhanced caps on completed trench areas during site operations. CNS has committed to capping all disposal trenches. CNS should schedule and locate trenches to consolidate areas for capping at the earliest possible time. This will minimize the cost and effort at closure.

Status: CNS has completed six capping phases covering approximately 96 acres. Additional capping is planned during the next three years of operations. Capping at the earliest possible date maximizes site performance. Indications of effective cap performance include seepage of water from the drainage layer around the perimeter of the cap after rainfall, drying of trench sumps and reductions in groundwater tritium concentrations.

10.3 Equipment and Structure Disposition

Recommendation: CNS recommends that any structures or equipment not needed for CNS or parent company operations or to be retained during or after closure be considered for disposition before Phase I closure. Unusable and unsalvageable facilities and equipment and materials on state property should be properly dispositioned. These actions will minimize the effort required during the closure period.

Status: In recent years, CNS has significantly reduced the amount of scrap material on and around the site. Heavy equipment and other assorted equipment in CNS and contractor storage yards have been removed. Above ground and underground tanks have been decommissioned, as has the on-site Electro-Con Facility.

10.4 Surface Water Management

Recommendation: CNS should improve surface water management on the west side of the disposal site to minimize active management. In 1998, large volumes of surface water accumulated on the west side of the site, backing-up close to trench areas and to levels requiring active pumping. The large volumes were due to high rainfall and the additional runoff from increased areas of enhanced cap. CNS should re-design water management features and processes to eliminate active water management such as pumping.

Status: In 2005, CNS completed the west pond expansion and west swale projects to address this concern.

10.5 Environmental Monitoring

Recommendation: CNS should continue efforts to abandon wells not required for the current operational and closure environmental monitoring programs, and investigate ways to reduce the quantity of monitoring well purge water requiring treatment.

Status: In recent years, CNS has evaluated and received DHEC approvals for operational environmental monitoring program enhancements including abandonment of certain wells.

10.6 Performance Objectives Verification Plan

Recommendation: CNS should develop a detailed plan for submittal to DHEC outlining the proposed approaches and criteria for verifying closure performance objectives. CNS should submit this plan for DHEC review, input and approval prior to submittal of the closure plan due one year prior to closure.

Status: CNS plans to prepare a separate submittal specifically requesting approval for proposed approach and criteria to satisfy closure performance objectives.

10.7 Records Transfer

Recommendation: CNS should continue efforts to convert paper records to microfilm to minimize current record volumes requiring storage and to prepare for an efficient transfer of records during closure.

Status: CNS maintains on-going microfilming programs. CNS plans to develop a coordinated microfilming plan to address the complete set of transfer records identified in Section 7 of this Plan.

11.0 SITE CLOSURE IMPLEMENTATION TASKS

Previous sections of this document have discussed the activities required to complete site closure and stabilization, the maintenance and monitoring activities needed for long-term care, and the adequacy of the current financial arrangements. This section identifies the proposed administrative process for effecting site closure and transfer to the custodial agency. This implementation plan outlines the schedule of activities to be performed during the remainder of current operations, Phase I closure, Phase I post-closure observation and into the in-region operations and long-term care periods. Use of this plan will help ensure an effective and efficient transition of the site from one phase to another.

11.1 Operational Period Tasks

CNS has performed disposal activities and site operations in accordance with the regulatory requirements established throughout the operational phase of the site. Any deficiencies discovered have been promptly corrected with regulatory agency concurrence. The site monitoring programs have expanded to provide an understanding of site performance. Closure of each trench is performed as a routine part of disposal operations. Certain significant closure activities, for example enhanced capping, have already been performed.

This closure plan recommends an efficient and cost-effective approach to closure of the Barnwell site. To implement the plan, CNS will need to obtain DHEC approval and authorization from the Budget and Control Board of the State of South Carolina for disbursement of monies from the decommissioning trust fund to perform the activities. Such authorizations have been made in the past.

CNS anticipates additional authorizations during site operations as CNS continues to implement closure tasks. Any authorizations depend on DHEC approval of the activities being consistent with the requirements for site closure. The following tasks will be accomplished in order to receive funds from the decommissioning trust fund for closure activities.

- Obtain a current statement of funds available in the Principal Account and the Income Account from the Treasurer of the State of South Carolina (State Treasurer).

- Obtain DHEC approval for proposed decommissioning work.

- Obtain written authorization from an authorized representative of the State Budget and Control Board to direct the distribution of the requested funds to Chem-Nuclear Systems, LLC.

The activities proposed to complete site closure have been evaluated to ensure that the established site closure and stabilization performance objectives will be met. Also, the cost to complete the final closure activities has been compared with existing monies in the decommissioning fund. The existing fund with the proposed funding mechanism will be sufficient to complete the site closure activities discussed in this document. Decommissioning funds remaining after completion of Phase I closure will be sufficient to establish funding for Phase II closure. Any remaining funds will be used for post-closure observation/long-term care expenses. In the event of inadequate funds in the decommissioning fund, CNS may obtain the monies needed from the long-term care fund.

The following tasks are planned to be completed prior to the start of Phase I closure:

- Submit the final Closure Plan for Phase I one year prior to start of closure. The final Phase I Closure Plan will document the closure activities completed to date and outline the remaining activities required for site decommissioning and closure.

- Obtain written authorization from the State Budget and Control Board directing distribution of the trust estate funds to CNS in accordance with a mutually agreed-upon schedule.

- Establish the administrative control mechanisms, that will be used to gain DHEC concurrence for completion of specific site closure activities.

- Submit a performance objectives verification plan, which will establish the basis for achieving objectives.

11.2 Phase I Closure Period Tasks

The activities discussed in Section 6.0 will be performed to complete the closure and stabilization of the Barnwell site. It is expected to take CNS about 15 months to complete these closure activities. The buildings will be surveyed and prepared as necessary for safe dismantlement and disposal on-site. The equipment not needed for in-region operations will be surveyed, decontaminated, if necessary, and removed from the site. Site surface areas will be surveyed to confirm the absence of significant residual contamination. Contaminated items and materials will be placed in a waste disposal trench. Salvageable equipment, if contaminated, will be transferred to another authorized license.

Disposal site areas will be graded and contoured to provide gentle slopes for proper surface water drainage away from the disposal trench areas. The disturbed areas will be topsoiled and seeded with native vegetation, as appropriate, and final radiological survey of the disposal trenches will be performed. The installation of permanent trench corner markers and identification markers will also be completed. Site monitoring and maintenance will continue during the closure period and will be paid for with closure funds.

Because of their site-specific experience, knowledge and capabilities, CNS plans to use existing site personnel to complete site closure, supplemented with contractors, as appropriate. This is an appropriate approach because personnel qualifications, existing training programs, site equipment and instrumentation have all been reviewed and accepted by DHEC.

The end of the Phase I closure period and start of the post-closure observation period will be defined by submittal to DHEC of a Closure Activities Completion Notification. This notification will be followed by a status report of performance objectives verification.

11.3 Phase I Post Closure Observation Period Tasks

At the end of Phase I closure activities, CNS will monitor the site for approximately five years to give DHEC sufficient opportunity to determine that the requirements of closure have been met. During post-closure, CNS will continue in-region operations, continue to maintain and evaluate environmental monitoring data, address regulatory reviews of the performance objectives verification report, perform additional evaluations, as required, and, towards the end of the post-closure period, submit a final performance objectives verification report.

The licensed area is leased from the State Budget and Control Board by CNS in accordance with the Lease Agreement. Adjustment of the site property boundaries has been proposed by CNS to provide adequate area for the continued stability of the buried waste and the planned maintenance and monitoring activities. The future uses of any remaining facilities and adjacent areas held by CNS have been considered in establishing proposed final site boundaries. In order to minimize the properties that will be unavailable for other uses and minimize maintenance costs, the proposed final site boundaries include only properties necessary for proper long-term care of the buried wastes.

During post-closure, CNS will establish mechanisms with the South Carolina Budget & Control Board for the routine distribution of monitoring and maintenance funds from the long-term care fund. These mechanisms should provide for the justification of funds requested and the accountability of funds received.

11.4 Long-Term Care Period Tasks

The long-term care period of the site will begin when Phase I site closure activities have been completed and upon satisfactory completion of the

post-closure observation. CNS proposes that long-term care commence for closed parts of the disposal site, concurrent with the start of in-region operations. Monies held in the long-term care fund will be used to pay for the long-term care activities required for these site areas. The 100-year institutional control period would not begin until the end of all operations, after Phase II closure and post-closure observation. Section 8.0 of this document details the long-term care activities and evaluates adequacy of the long-term care fund.

To implement the proposed plan, it may be necessary for the State Budget and Control Board and CNS to amend the current Lease. The following items in the current Lease should be addressed.

- Paragraph 1. (4-6-76) provides the legal description of the leased property. Property boundaries may be adjusted to provide the optimum property for site stability and long-term care.

- Paragraph 2. (4-6-76) states that the date of termination of this lease is April 5, 2075.

- Paragraph 7. (7-15-86) originally established the escrow account for surveillance and maintenance of the site. Several amendments to this paragraph have resulted in increasing the payment to $2.80 for each cubic foot of waste as of the July 15, 1986 amendment.

- Paragraph 8. (9-11-79) requires CNS' compliance with regulatory requirements. Mutual agreement for CNS' continued use of the site for another reasonable purpose is allowed provided that the perpetual care fund is continued. The State Budget and Control Board may continue using portions of the site for storage and disposal of radioactive waste.

The long-term care period as proposed in this plan is divided into four stages. Stage I is the first 36 years comprising in-region operations, Phase II closure, and Phase II post-closure observation; Stage II is the first 25 years of the actual institutional control period; Stage III is the

second 25 years; and Stage IV is the final 50 years of institutional control. The annual routine maintenance and monitoring requirements should decrease over time since the disposal trenches will eventually stabilize and radioactive decay will reduce the waste inventory.

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13.0 SITE DRAWING

CNS drawing B-500-D-300, “10 Year Land Utilization Plan” shows current status and future plans for disposal operations at the Barnwell Site.

DRAWING B-500-D-300
AVAILABLE IN HARDCOPY FORM ONLY